

NEW
from
HISTORY
WAR

★ 75TH ANNIVERSARY SPECIAL ★

THE DAM BUSTERS

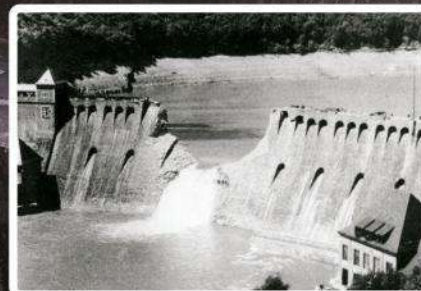
INSIDE THE MOST DARING RAID OF WORLD WAR II

148
PAGES OF
HISTORICAL
IMAGES

**Digital
Edition**



FIRST
EDITION



KEY PEOPLE • DETAILED PLANS • LASTING LEGACY

**HISTORY
WAR**
Book of the

**THE
DAM
BUSTERS**

INSIDE THE MOST DARING RAID OF WORLD WAR II

On the night of the 16th - 17th May, nineteen Lancaster bombers took off from an air base in Lincolnshire. Three turned back, unable to complete the mission. Of the sixteen that made it to the Ruhr valley, only half returned, and even fewer successfully dropped their bouncing bomb on the dams. But to the Allies, the Dambusters mission was a success that they desperately needed. Over the following pages, discover the incredible story of the Dambusters raid, uncover rare artefacts and documents - including maps, flight log books, sketches and top-secret letters - and find out how Squadron 617 lived on after the raid on the Ruhr.

THE DAM BUSTERS

INSIDE THE MOST DARING RAID OF WORLD WAR II

Future PLC Richmond House, 33 Richmond Hill,
Bournemouth, Dorset, BH2 6EZ

Editorial

Author **John Sweetman**
Editor **Philippa Grafton**
Designer **Steve Dacombe**
Editor in Chief **Jon White**
Senior Art Editor **Andy Downes**

Cover images

Nicolas Trudgian

Photography

All copyrights and trademarks are recognised and respected

Advertising

Media packs are available on request
Commercial Director **Clare Dove**
clare.dove@futurenet.com

International

International Licensing Director **Matt Ellis**
matt.ellis@futurenet.com

Circulation

Head of Newstrade **Tim Mathers**

Production

Head of Production **Mark Constance**
Production Project Manager **Clare Scott**
Advertising Production Manager **Joanne Crosby**
Digital Editions Controller **Jason Hudson**
Production Managers **Keely Miller, Nola Cokely,**
Vivienne Calvert, Fran Twentyman

Management

Chief Operations Officer **Aaron Asadi**
Commercial Finance Director **Dan Jotcham**
Editorial Director **Paul Newman**
Head of Art & Design **Greg Whitaker**

Distributed by Marketforce, 5 Churchill Place, Canary Wharf, London, E14 5HU
www.marketforce.co.uk Tel: 0203 787 9001

This bookazine is published under licence from Carlton Publishing Group. All rights in the
licensed material belong to Carlton Books Limited and it may not be reproduced, whether in
whole or in part, without the prior written consent of Carlton Books Limited.
© 2018 Carlton Books Limited

The content in this book was previously published in the Carlton book The Official Dambusters
Experience

The Dambusters word is trademark of the UK Secretary of State for Defence

Book of the Dambusters First Edition
© 2018 Future Publishing Limited

We are committed to only using magazine paper which is derived from responsibly managed,
certified forestry and chlorine-free manufacture. The paper in this magazine was sourced
and produced from sustainable managed forests, conforming to strict environmental and
socioeconomic standards. The manufacturing paper mill holds full FSC (Forest
Stewardship Council) certification and accreditation

All contents © 2018 Future Publishing Limited or published under licence. All rights reserved.
No part of this magazine may be used, stored, transmitted or reproduced in any way without
the prior written permission of the publisher. Future Publishing Limited (company number
2008885) is registered in England and Wales. Registered office: Quay House, The Ambury,
Bath BA1 1UA. All information contained in this publication is for information only and is, as far
as we are aware, correct at the time of going to press. Future cannot accept any responsibility
for errors or inaccuracies in such information. You are advised to contact manufacturers and
retailers directly with regard to the price of products/services referred to in this publication. Apps
and websites mentioned in this publication are not under our control. We are not responsible for
their contents or any other changes or updates to them. This magazine is fully independent
and not affiliated in any way with the companies mentioned herein.



Future plc is a public
company quoted on the
London Stock Exchange
(symbol: FUTR)
www.futureplc.com

Chief executive **Zillah Byng-Thorne**
Chairman **Richard Huntingford**
Chief financial officer **Penny Ladkin-Brand**

Tel +44 (0)1225 442 244

Part of the

HISTORY of WAR

bookazine series



CONTENTS

FOREWORD	008
INTRODUCTION.....	009
FIRST WORLD WAR ORIGINS.....	014
INTER-WAR YEARS	016
ACHILLES' HEEL	018
PROPOSED ATTACKS	020
ENTER WALLIS	022
TARGET MÖHNE.....	024
BOMBER COMMAND AT WAR.....	026
GENESIS OF THE "BOUNCING BOMB"	038
DEVELOPMENT	040
SCIENTIFIC DOUBTS	048
SERVICE OPPOSITION	050
CHANGE OF MIND	052
SQUADRON X	054
TRAINING	066

FINAL TRIALS	068
LATE DRAMA.....	070
LAST 48 HOURS	080
PLAN OF ATTACK	082
TAKE OFF	084
FIRST WAVE	086
SECOND WAVE	088
THIRD WAVE	090
IMPACT GERMANY	110
EPIC FEAT OF ARMS	112
ACTION GERMANY	114
REFLECTION	126
OUR WIZARD BOFFIN	128
DAMBUSTERS AND BEYOND	130
70TH ANNIVERSARY FLIGHT	142
CREDITS	144



FOREWORD

As one that took part on the Dams Raid although not reaching my target due to flak damage sustained when crossing the Island of Vlieland, I am naturally interested in the contents of this book and its historical accuracy. When I entered the RNZAF on 7 July 1941 I never thought for a moment that I would take part in an operation that would be recognised at the time and over subsequent years as a major event in the history of the British War Effort in the air.

Likewise, when on 97 Squadron I volunteered with my crew to serve on a new squadron being formed to undertake a special operation, I had no idea of what the target may be. This lack of knowledge of the target was also shared by all the Squadron's aircrew until the final briefings.

On formation of the Squadron towards the end of March all crews immediately embarked on six weeks of continuous and intensive low level training. This involved the pilot becoming proficient at flying at tree top height and most importantly becoming adept on deciding when to gain height in order to clear features on the route ahead.

An equally important aspect of our training programme was for relevant crew members to be able to quickly identify landmarks on the track ahead to assist the navigator as to where we were at, much more difficult than if flying at height where you can see for many miles ahead of you.

This book traverses the development of aerial bombing, from the use of the flimsy biplane during the 1914–18 War and the use of modified hand grenades as attacking weapons, through to the use of the Upkeep against the Ruhr Dams. It progresses, also, to the use of the Tallboy bomb against special single targets including the German battleship Tirpitz with devastating effect, and finally the 22,000lb (10,000 kilos) Grand Slam on the Bielefeld Viaduct.

The book covers in detail the efforts of Barnes Wallis, firstly in relation to his early concept of an earthquake bomb and when that possibility was discarded for practicable reasons to the invention, trials and development of the Upkeep bouncing bomb and ultimately to its successful use against the Ruhr Dams. Without his sharp and inventive mind and his tenacity and perseverance, the Dams Raid would never have happened, nor would his early thoughts of an earthquake bomb have eventually been embraced and carried through to the production of the Tallboy and the Grand Slam with such great effect.

I commend this book with the history of the Dams Raid as its central theme together with accompanying illustrations to readers interested in this aspect of 1939–1945 War history.

J.L. Munro CNZM DSO QSO DFC JP
Squadron Leader (Retired)



Right: Flight Lieutenant J.L. Munro. Munro was promoted to Squadron Leader in February 1944

INTRODUCTION

The sensational destruction of massive German dams by a single Lancaster squadron, which was raised and trained in eight weeks to deliver with stunning accuracy a cumbersome, unique revolving weapon from low-level at night continues to capture public and media imagination.

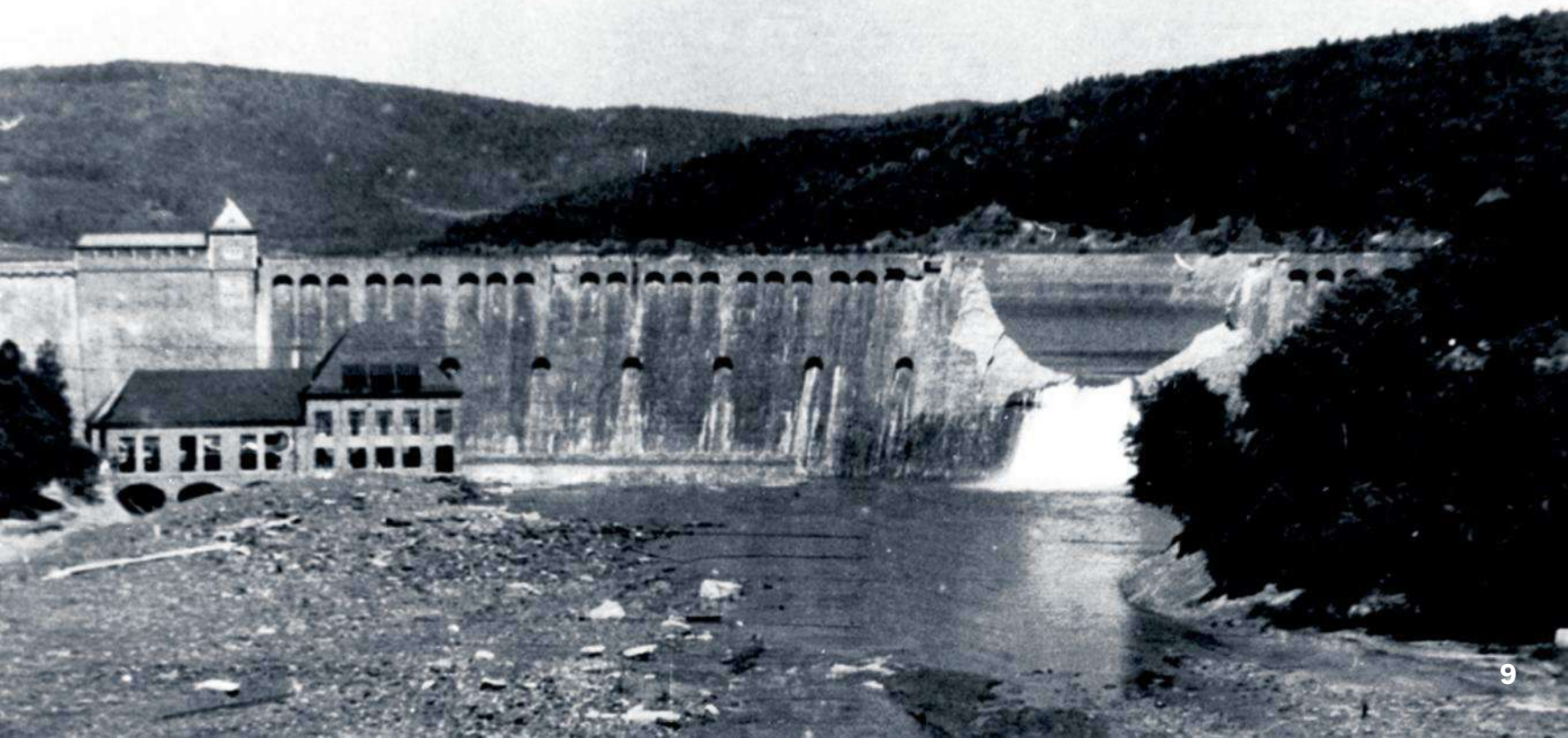
However, the story of a determined scientist (Barnes Wallis) striving to overcome unwarranted scepticism about his ingenious scheme and a photogenic, young squadron commander (Guy Gibson) leading his crews gallantly into battle has the whiff of a *Boys' Own* adventure. But military operations are more complex and dangerous than that.

Planning for the raid on the Ruhr began in the Air Ministry six years earlier, long before Wallis became involved, and the roots of the concept can be traced to the First World War. During the inter-war years, belief that "the bomber will always get through" prompted hope that demolition of the Möhne and Sorpe dams would fatally undermine Germany's

manufacturing capability in the industrial Ruhr. In 1938, "reservoirs and dams" were declared priority targets; the list, including the Möhne and Sorpe, soon extended to seven dams connected with the Ruhr and Weser valleys.

Various plans to attack these proved impracticable. Not until 1942 was the bouncing bomb born. Like the authors of previous proposals, Wallis encountered scientific doubts and Service opposition before the operation against the seven dams identified pre-war was approved on 26 February 1943.

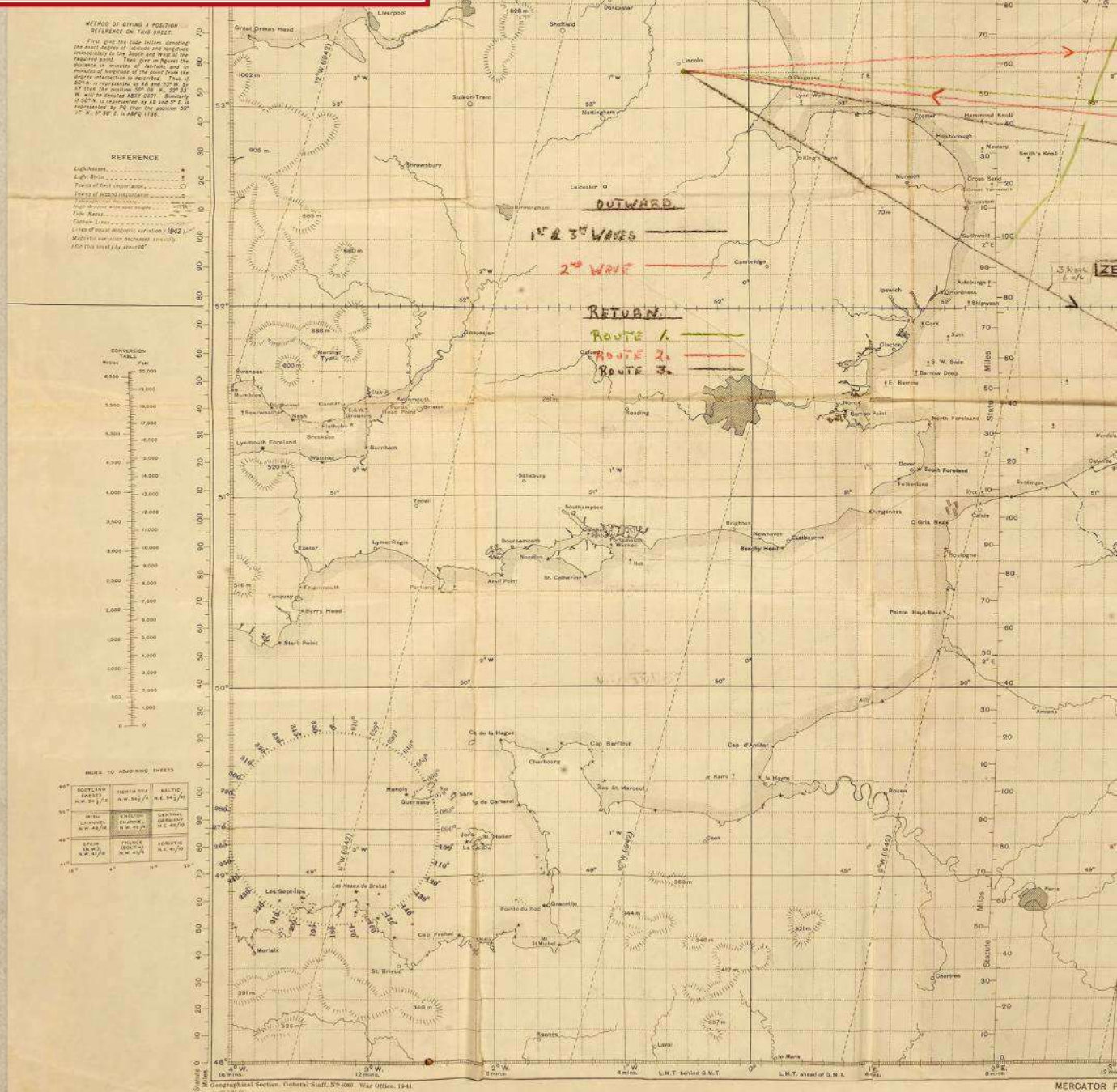
The special squadron to deliver Wallis's weapon began to assemble on 21 March, and the final test of the bouncing bomb was not completed until 15 May, when operational details of the raid launched the following day were also finalised. Contrary to exaggerated claims in its wake, the Dambusters Raid did not drastically affect Germany's ability to fight on, but it gave hope that the tide had turned in the Allies' favour. Later evidence revealed, too, that it had considerably more impact than its critics have allowed.

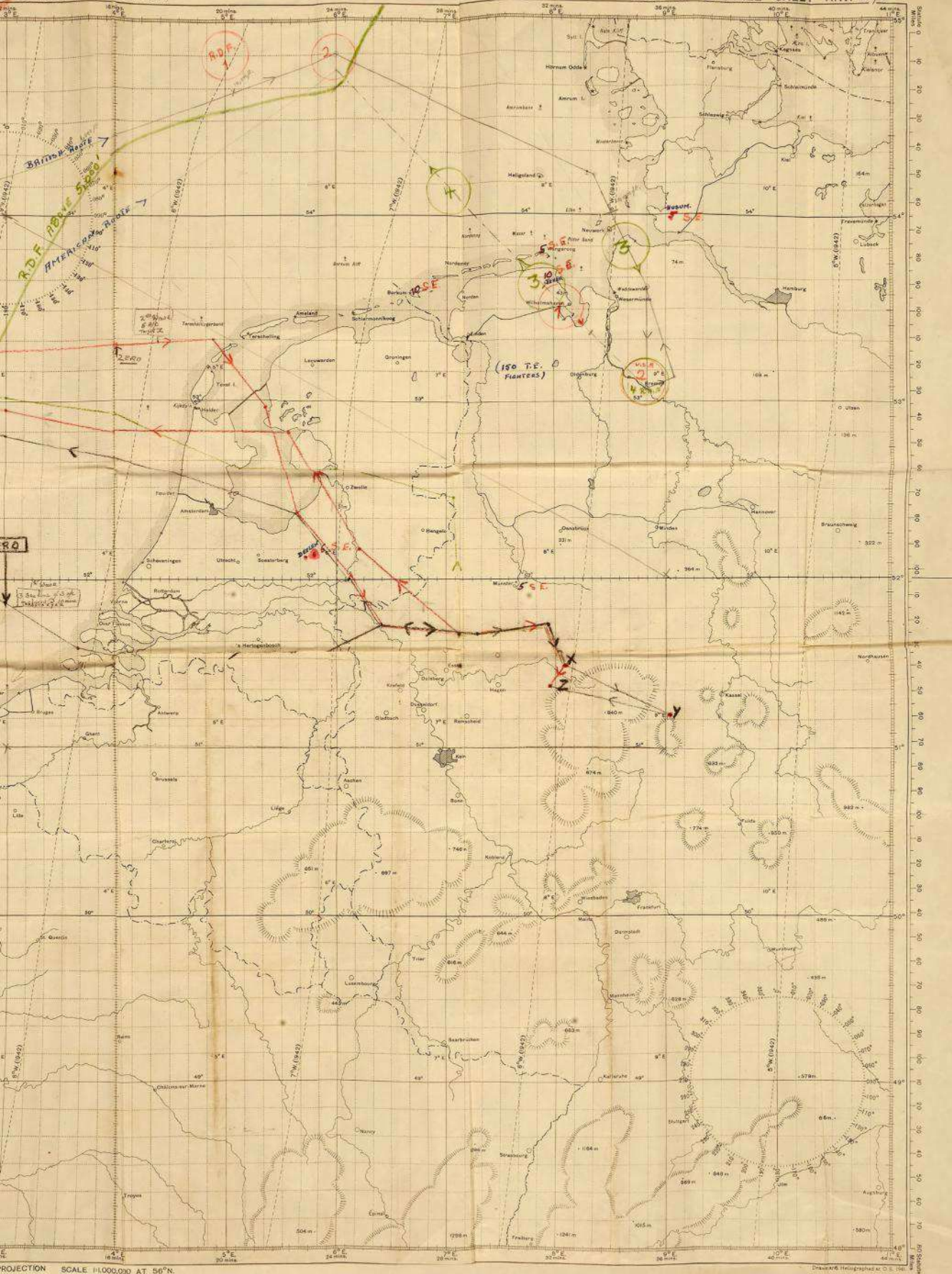


ITEM 01

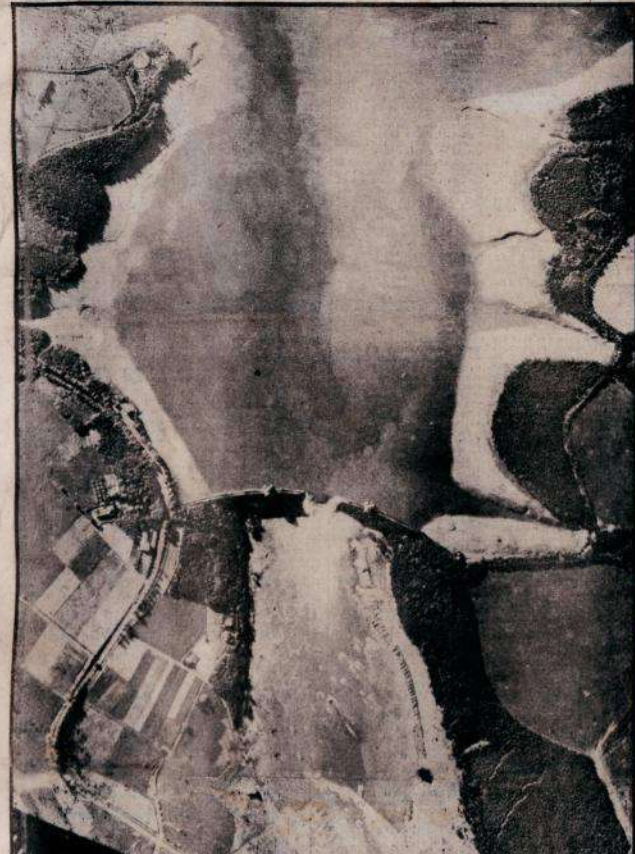
OFFICIAL MAP SHOWING THE PLANNED ROUTES TO AND FROM THE DAMS

Gibson's First Wave and later Third Wave aircraft would fly via Southwold across the North Sea to the Scheldt estuary, then on to the Rhine before skirting the Ruhr towards the Möhne Dam. Second Wave Lancasters bound for the Sorpe (red line) would negotiate the North Sea to the Frisian Islands, fly over the IJsselmeer (Zuider Zee) to join the First Wave route at the Rhine. Targets X (Möhne), Y (Eder) and Z (Sorpe) are all identified. The route Gibson's aircraft would take from the Eder to the Sorpe, if any unused Upkeeps were available, is also marked. The exit routes are depicted in green, red and black with return arrows.





FLOODS FROM MINED DAMS RUSH ON RUHR TOWNS



Smashed Dam Makes Greatest Air Picture of War

AN R.A.F. reconnaissance picture taken soon after the attack that shows at a glance the devastating effects of the damage to the Mohne Dam.

Through the 200-ft. breach the water is pouring fast. The lake has been drained of nearly all its contents. Where the power station stood—it stands clearly in the picture on left taken before the raid—is nothing but a mass of frothy, tumbling water, cascading wildly.

Below the breach the torrent from the lake has overflowed and destroyed the dam surrounding the compensating basin.

In the lake itself the receding waters leave white mud banks ridged like contours on a map.

Already the appearance of the Mohne Dam is fast changing. When the last pilot saw it before he turned for home, he had some difficulty in finding the right end of the reservoir because the shape had changed.

The map below shows the positions of the Mohne and Eder Dams and the Sorpe Reservoir in relation to the industrial network of the Ruhr and the rivers the head waters of which the dams command.



Prince Umberto at War Council

CROWN PRINCE UMBERTO has taken the place of King Victor Emmanuel at meetings of the Supreme War Council in Rome.

The Italian Cabinet has been in almost continuous session since Saturday morning.

Musolini and Marshal Cavallero, de Bonis, Cavallero and Graziani have been present.

Rome radio said this exhortation to the nation.

The Italian people are Army and Navy. They are the backbone of our nation.

The great war in which all our people are taking part is the most important in the history of our nation.

It is the duty of every Italian to do his utmost for the victory of our arms.

Bomber Twins Tie For the D.F.C.

TWIN brothers who enlisted, trained and were commissioned together, and are now pilot officers in the same Royal New Zealand Air Force Bomber Squadron, are to receive the D.F.C. together.

The twins are Anthony Martin Singer and Peter Lloyd Singer, both 24. They were born in Weybridge, Surrey, and now live in Gibraltar.

They attacked the same targets in Gibraltar and were both awarded the D.F.C. for their part in the same daring mission.

The official account of their deeds is the latest R.A.F. award despatches. Anthony is "conspicuously reliable, determined, brave, and Peter is a keen, dependable, and a most capable, energetic, initiative and determined.

Power Stations Crumple: Rail and Road Bridges Collapse: "A Major Victory"

MILLIONS OF TONS OF WATER WERE SWEEPING OVER HITLER'S GREAT ARMS CENTRE IN THE RUHR LAST NIGHT AFTER R.A.F. LANCASTERS, FLYING THROUGH A DENSE SCREEN OF METAL FROM A.A. GUNS, HAD SHATTERED TWO OF THE BIGGEST DAMS IN GERMANY WITH MINES.

Within a few hours of the raid, one of the most daring ever carried out by Bomber Command crews, Berlin officially admitted heavy civilian casualties.

Waters unleashed from the Mohne dam, which held 134,000,000 tons, streamed in an ever-growing tide of devastation towards Dortmund, one of the big munitions cities of the Ruhr, only 25 miles to the west.

MARSHALLING YARD UNDER WATER

Reconnaissance by R.A.F. "spotters" soon after the raid showed: The Mohne dam breached for at least 100 yards. The power station below the dam swept away.

Railway and road bridges in the Ruhr Valley crumpled like toys.

Other power stations destroyed or damaged. A railway marshalling yard under water.

Floods swiftly spreading and water rising rapidly in the Dortmund area.

RIVER EDER IN FULL FLOOD

Floods from the breached Eder dam were already as great as the flow of water in the Ruhr Valley, but the country here is flatter and the water likely to spread over a greater area.

Not far from the Mohne dam lies the small town of Soest, which would be gravely imperilled by the rushing waters.

To the east, where the Eder dam, holding 302,000,000 tons of water, was split, the River Eder was seen to be in full flood.

Twenty-five miles west of Cassel—an arms town often attacked by R.A.F. bombers—the Eder dam is claimed by the Germans to be the biggest in Europe. Power stations supplying a great area would be affected by the breaching of its gigantic walls.

A MAJOR VICTORY, SAYS Bomber CHIEF

Late last night Air Chief Marshal Sir Arthur Harris, Commander-in-Chief, Bomber Command, congratulating the Lancaster crews who tore open the dam, told them that there "had won a major victory... the effects of which will disaster."

Wing-Comdr. G. P. Gibson, D.F.C., D.F.C., who planned and led the breath-taking raid, flew low over the Mohne dam to draw the German gunners while other Lancasters swept down to attack from 100 ft.

With his machine-guns blazing, he swooped through the intense barrage and forced the German gunners to waver.

Jets of water were flung hundreds of feet into the air when the mines exploded and both dams were seen to be quaking before the last aircraft turned for home. Wing-Comdr. Gibson was among those who made a safe return. Eight Lancasters were lost.

D.S.O. SWOOPED DOWN TO DRAW FIRE

Here is the story of the raid—which may prove catastrophic for Hitler's biggest source of war weapons—as told by the Air Ministry News Service:

For many weeks picked Lancaster crews have been training for this great operation. They worked in complete secrecy on a bomber station which, as far as possible, was cut off from any contact with the outside world.

Only about half a dozen other men in the whole of Bomber Command knew what they were doing. The weather and light were exactly right, they carried out the operation. Its purpose was to subject the whole Ruhr Valley to almost as severe an ordeal as it has undergone by fire in the last three months, and to do the same for another industrial area farther west.

The Lancaster crews knew how much depended on their success or failure. The opportunity might never come again, and it was an opportunity, as they knew, of doing as much damage as could be done by thousands of tons of bombs dropped on many nights running.

Wing-Comdr. Gibson, who was also in charge of the whole operation, personally led the attack on the Mohne dam. After he had dropped his mines he flew up and down alongside the dam to draw the fire of the light anti-aircraft guns emplaced on it.

Guns were poking out of slots in the walls of the dam. His gunners fired back as the wing-commander repeatedly flew through the barrage and this had the effect of making some of the enemy gunners waver. A flight-leader, who dropped his mines later, was in a better position to see what actually happened to the dam.

It was able to watch the whole process," he said. "The wing-commander's lead was placed out right and a great deal of water went up 3000 ft. into the air. A second Lancaster attacked with equal accuracy, and there was still no sign of a breach."

GREY JETS OF WATER

"Then I went in and we caused a huge explosion, up against the dam. It was not until another lead had been dropped that the dam at last broke. I saw the first jet very clear in the moonlight."

One pilot said that the jets of water were so powerful that they were hurling in all directions for at least 200 ft.

A witness with a D.F.M. was the Sorpe dam. "I found some trouble in finding the right end of the reservoir," he said, "because there was already a new sheet of fire and flames about the water was spreading fast."

To make the job even more difficult, the water was so dark that it was impossible to see the dam. The water was so dark that it was impossible to see the dam.

German Ships From Far East Were Scuttled

TWO more blockade runners have been scuttled after interception by our ships, states an Admiralty communiqué.

One, the German armed ship *Silvaplana* (4,790 tons), from the Far East with rubber and tin, was sighted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.

The German motor vessel *Regenwald* (1,000 tons), also from the Far East, was intercepted by the cruiser *Adventure* (Capt. H. G. Bower, R.N., M.V.O., R.N.), about 200 miles off Cape Finisterre.

Her crew abandoned ship, lateral explosion rent her hull and she sank. All the crew, including over 100 German naval men, were saved.



This is the man who led the raid, Wing-Comdr. G. P. Gibson, D.F.C., D.F.C., double D.F.C.—the bomber pilot—nearly 200 sorties to his credit—before he was officially described as having "a conscience for danger" record "shines it."

BERLIN OFF THE AIR

Berlin radio went off the air shortly after midnight for technical reasons.

LONDON SIRENS

An Alert was sounded in the London area shortly before midnight, when a small number of enemy raiders were reported to be in the vicinity.

There was gunfire, but "Raiders passed" was heard from the air.

At 10.33 p.m.—5.19 a.m. Mean wind 124 mph, sets 8.1 a.m. tomorrow. Full Moon tomorrow.

U-boat strike...



The great sun sets over the broad Atlantic; his red sheen gleams on the water, on a few lone fishing smacks. The Catalina drowns overhead—watching... A periscope breaks the surface. Only a feather of foam but Taffy spots it. "On the horizon low, sir!" Alert! The bomber springs to life. All ready—nose down... U-boat crash dives—Bo-o-m-m... "Wonder if we hit her?" "Yes—there she is coming up again!" Give her the works Strike! Boom—Boom—Boom Great spouts of foam rise and disperse below. Circle round—all eyes scan the sea. "Oh she's looking... Oh! spreading... bubbles... bubbles." Black in the dusk the iron stern rises out of the water. Then... slides... Slowly... DOWN. Another killer finished.

But all are not finished—not yet; there are hundreds of U-boats to be struck. The enemy is building hard. We must multiply our hunters. That means working harder and saving harder, until no U-boat dares to molest our ships and peace reigns once more over land and sea. SAVE MORE.

... - Wings for Victory

ITEM 02

**THE NEWS CHRONICLE FRONT PAGE
18 MAY 1943**

Like other national and provincial newspapers, the *News Chronicle* published a reconnaissance photo of the breached Möhne, dubbing it the "Greatest Air Picture of the War". The paper exclaimed that "millions of tons of water were sweeping over Hitler's great arms centre in the Ruhr", the "River Eder in full flood" and repeated Sir Arthur Harris's claim of "a major victory". The importance of the raid for civilian morale is indirectly revealed on this same page with a note that sirens had been sounded the previous night in London and the pleas for money via the "Wings for Victory" campaign to provide more aircraft to combat the increasing U-boat menace.

FIRST WORLD WAR ORIGINS

The battle in the air during WWI proved that technology had a long way to go before any war could be truly won in planes

At the outbreak of the First World War, in the words of one Royal Flying Corps observer, "a few BE2s and Avros ... staggered across the Channel to co-operate with the Army in France." In their flimsy biplanes, powered by a single 70hp engine, the airmen's sole task was to reconnoitre enemy formations, their only means of self-defence rifles, revolvers or shotguns. Within four years, British pilots were flying bombers powered by four 375hp engines capable of reaching Berlin from England.

Bombing began with crews randomly tossing modified hand-grenades or explosive darts out of open cockpits. Technological advances, though, led to the development of specialised bombers equipped with bomb-sights, manufactured bombs, substantial bomb-loads and machine-guns for self-defence.

During 1916, bombers based in eastern France began to attack enemy armament factories, iron foundries and blast furnaces in Alsace Lorraine. Although they had limited success, Lord Montagu (a strong supporter of military air power) called for wider raids on "the most important war factories" in the Rhine valley, arguing that "continuous long-range bombing is ... the most promising method of smashing the enemy." Specifically, Lord Kitchener, the British Secretary of State for



Above: Before bomb-racks and bomb-sights were developed, projectiles were carried in the cockpit and dropped over the side of the aircraft

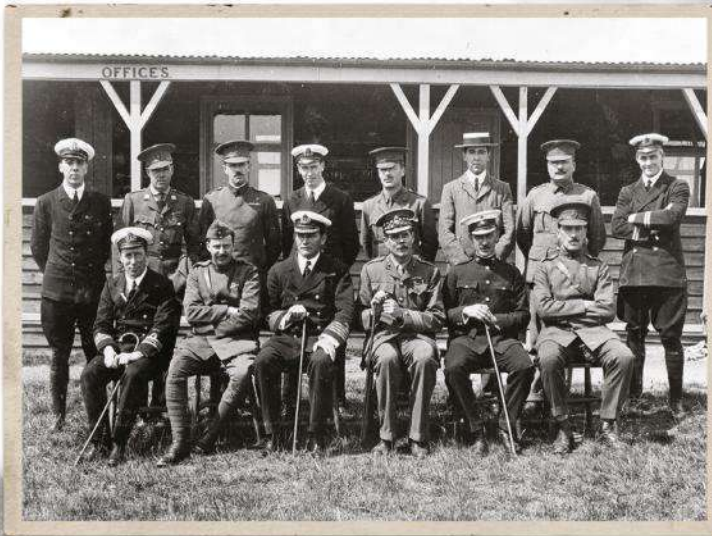
MAJOR-GENERAL SIR HUGH TRENCHARD (1873-1956)

A regular army officer, Hugh Montague Trenchard served in India, the Boer War (where he was severely wounded in one lung) and Nigeria. Aged 39, he learnt to fly and was posted to the Royal Flying Corps Central Flying School, where as a lieutenant-colonel he became assistant commandant and acquired the nickname "Boom" for his loud mode of address. In November 1914, he led the RFC's First Wing in France, and the following year took command of the whole RFC on the Western Front, practising the aggressive use of air power. Advancing to major-general, he was appointed KCB in January 1918.

Briefly the first Chief of the Air Staff (CAS) to the newly-created RAF, in June 1918 Trenchard took command of the Independent Bombing Force in eastern France, with the primary aim of attacking enemy industries. He was CAS again 1919-29, when he foresaw bombers focusing decisively on an enemy's industrial base in a future war. On 5 May 1943, then Marshal of the Royal Air Force Lord Trenchard, he visited 617 Squadron at Scampton, and after Operation Chastise signalled: "Many congratulations on destruction of dams; it is splendid. Please congratulate Gibson and all concerned from me."



"MANY CONGRATULATIONS ON DESTRUCTION OF DAMS"



Above: Geoffrey de Havilland's DH4 was the most successful British day bomber of 1917-18. It had a 375hp engine, a speed of 133.5mph (215kph) at 10,000 feet (3,048 metres) and a ceiling of 23,000 feet (7,010 metres)

Left: The RFC Central Flying School pictured in 1913 before a separate Royal Naval Air Service was created in July 1914. Lieutenant-Colonel H.M. Trenchard sits third right

Below-left: A 1,650lb (748kg) bomb with 800lb (363kg) of explosive, the largest used by the British on the Western Front and first dropped on 24/25 July 1918. The standing airman shows scale

War, advocated destruction of the Krupps armament complex in Essen. As yet, though, available aircraft had neither the range nor capability to mount such an effective campaign, and the bombing force at Luxeuil soon dispersed.

Renewed impetus for an assault on German war industries came from Lieutenant-General J.C. Smuts (author of two reports on the future of air power) in August 1917. He forecast that "the air battle front will be far behind on the Rhine and ... its continuous and intense pressure against the chief industrial centres of the enemy ... may form an important factor in bringing about peace." Rear-Admiral Mark Kerr (a qualified pilot who supported the creation of an Air Ministry and the RAF) agreed that "the quickest way to get a superiority over the enemy ... is to destroy his factories of production." In October, alarmed by recent damaging daylight raids on London, Lord Cowdray, president of the Air Board (the forerunner of the Air Ministry), called for bombers "to lay their (German) factories flat." As a result, a bomber fleet was once more assembled in eastern France with the Prime Minister being assured that "it is intended to attack, with as large a force as is available, the big industrial centres on the Rhine and in its vicinity." As even more squadrons

concentrated around Ochey (south-west of Nancy), a further dimension was added to the bombing campaign, thus ensuring "the morale of workmen is so shaken that output is seriously interfered with." Henceforth, "strategic bombing" would have twin aims: the destruction of industrial targets; and the undermining of civilian morale.

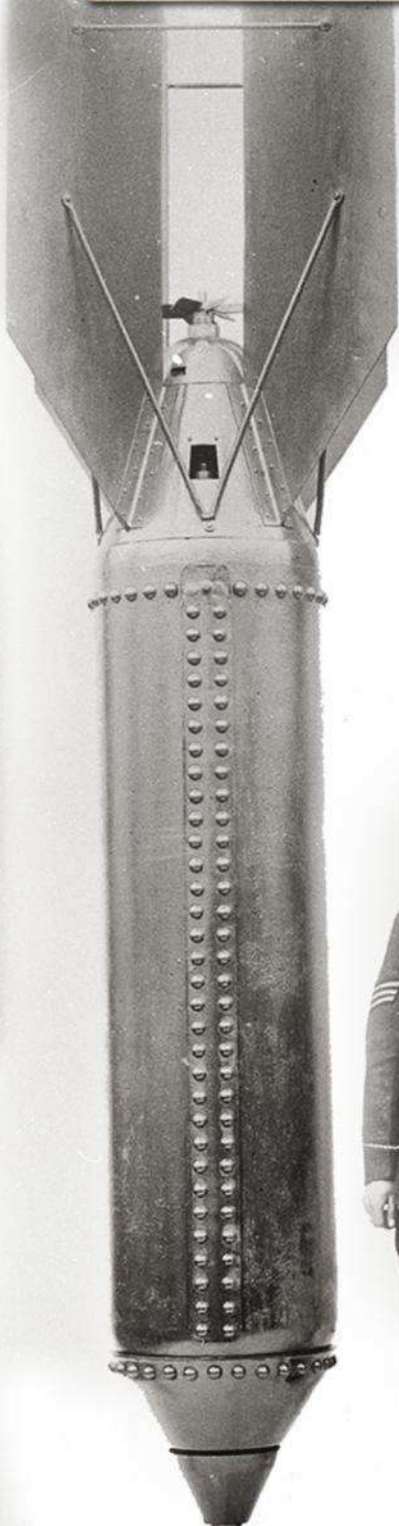
In June 1918, an Independent Bombing Force (IBF) superseded VIII Group (the Ochey formation), its mission "to carry out a definite policy - viz. the bombing of German Munition Factories ... root industries ... to cripple the resources of the German armies in the field." Its commander, Major-General Sir Hugh Trenchard, had at his disposal 10 long-distance squadrons, including some equipped

with twin-engine machines. He signalled one of them: "Bomb Mannheim and a squadron which does this materially assists the progress of the war." In three months, the IBF dropped 246 tons of explosives, in which a single 1,650lb (750kg) bomb reputedly wiped out a whole factory at Kaiserlautern.

In October 1918, plans were advanced for British, French, Italian and American squadrons to form an Inter-Allied Independent Force (IAAF) under Trenchard "to carry war into Germany by attacking her industry." In practice, this international organization failed to materialise, the paper IAAF simply comprising the 10 IBF squadrons. Nor did the new four-engine bomber with a bomb-load of 7,500lbs (3,400kg), standing by in Norfolk, fly operationally before the Armistice. Nevertheless, by 1918 the concept of air raids directed at an enemy's industrial base had been fashioned and, however imperfectly, put into practice.

THE EARLY BOMBER OFFENSIVE

The Airco DH4 two-seat biplane day bomber first flew in August 1916, and went into service with No. 55 Squadron Royal Flying Corps (RFC) in March 1917. Powered by one 250hp Rolls Royce Eagle engine, it had a maximum speed of 119mph (192kph) at 3,000 feet (900 metres) and a ceiling of 16,000 feet (4,900 metres). It carried two 230lb (105kg) or four 112lb (51kg) bombs in racks under the fuselage or lower wing. In the front cockpit, the pilot manned one Vickers 0.303-in fixed machine-gun and the observer in the rear had either one or two Lewis 0.303 machine-guns mounted on a Scarff ring. No. 55 Squadron flew DH4s in the Independent Bombing Force, which attacked German industrial targets in 1918. One pilot of a DH4, the future Biggles author 2nd Lieutenant W.E. Johns, condemned it as a potential "flaming coffin", because the petrol tank sat between the two cockpits. He also claimed that the roar of the engine gave crew members a painful headache. On 16 September 1918, returning from a raid on Mannheim, Johns's machine was shot down and he became a prisoner-of-war.



INTER-WAR YEARS

1919-1938

In a period of peace following WWI, the threat of another war spurred plans for bombing offences

Shortly after the end of the First World War, Major-General Sir Hugh Trenchard (now Chief of the Air Staff) declared, "there can be no doubt that we must be prepared for long-distance operations against an enemy's main source of supply".

Very soon, in 1919, a Handley Page V/1500 bomber was credited with bringing the Third Afghan War to a close by bombing Kabul. During the 1920s, belief in the decisive power of the bomber increased with the success of Imperial Policing. Stationed in Mesopotamia (modern Iraq), Squadron Leader A.T. (later "Bomber") Harris explained how his squadron operated: "When a tribe started open revolt we gave warning to all its most important villages by loudspeaker from low-flying aircraft and by dropping messages that air action would be taken after twenty-four hours." If the warnings were ignored, bombs destroyed the villages and air patrols discouraged the inhabitants from returning until "they decided to give up, which they invariably did."

Bombers were now regarded as "the predominant weapon", and a wide range of writers, including former senior officers, argued that they were the best means of national defence. Strategic bombing, long-range aircraft striking at the centre of an enemy's war production, thus enjoyed increasing support.

This spawned the concept of an "aerial knock-out blow" against a foe's industrial base delivered before or immediately after war broke out. The contemporary RAF Manual stated that "the bomb is the primary weapon of air power. The bomber is the means of conveying it to its target."

In 1932, Stanley Baldwin, a cabinet minister, exclaimed that "the bomber will always get through", and two years later reinforced the role of the long-range bomber. "The old frontiers are gone. When you think of the defence of England you no longer think of the chalk cliffs of Dover, you think of the Rhine." He might have added that the Ruhr, heart of Germany's war industry, lay close to that river. Flying long distances, however, was one thing, hitting a specific target another. That, too, could apparently be guaranteed. A report of activity on the North-West frontier of India maintained that precision targets had been hit with impunity.

An alarming assertion, that the newly-created Luftwaffe would muster 1,500 aircraft by March 1937, spurred plans for a bombing offensive, enhanced by the creation of Bomber Command in 1936. Twin-engine bombers with enclosed cockpits and more substantial bombloads were also beginning to replace open cockpit machines like the Hawker Hart and Handley Page Heyford. Those new machines were overdue. In September 1938, pilots ready



BOMBER DEVELOPMENT

By the Armistice, single-engine bombers like the DH4 and twin-engine machines such as the Handley Page O/100 and Handley Page O/400, which had been the mainstay of the Independent Bombing Force, were ready to give way to heavier machines. Specifications for a long-range bomber, powered by four 375hp engines with a top speed of 90mph (145kph), A crew of five to seven, a bomb-load of 7,500lbs (3,400kg) and up to five machine-guns, had already been drawn up. The Handley Page V/1500 (pictured above, near Dunkirk in April 1918, note the exposed gunner forward of the engines), was designed to meet these requirements, flew in May 1918. With a service ceiling of 11,000 feet (3,350 metres) and six hours endurance, it had the ability to bomb Berlin from England, and three machines were standing by in Norfolk for that operation when hostilities ceased. Transported by sea to India and reassembled there, in May 1919 an HP V/1500 bombed Kabul and, in so doing, was credited with ending the Third Afghan War. This evident success helped to foster the belief that bombers would be decisive in forthcoming conflicts.





Above: A Westland Wapiti engaged in imperial policing on the North-West frontier of India. It carried two machine-guns and a 580lb (264kg) bomb load. Note the tail skid

to attack Germany in Heyfords should the Munich Conference fail to reach an agreement were advised that they might well run out of fuel on the way back. If so, they should bale out over the Netherlands.

Annual exercises across Britain further encouraged the belief that the bomber would indeed get through. Guy Brisbane, who would conclude the Second World War as a decorated group captain, drily remarked that he "was never lucky enough to be in a formation which was intercepted and attacked." Flying Officer Guy Gibson similarly observed that invariably he evaded aerial defences during exercises

and on one occasion went on to "flatten" RAF Abingdon, near Oxford.

The replacements for the Hart and Heyford, with bomb-loads up to 7,000lbs (3,200kg) and equipped with multi machine-guns, greatly heightened confidence in the bomber as an effective, aggressive weapon. They also fostered the belief that, if a formation of bombers closed up, their combined defensive firepower would drive off fighters.

Destroying enemy industrial targets, as Trenchard had astutely predicted 20 years previously, was therefore very much on the planning agenda.

Below: The bombing of a Chabaish village in Mesopotamia (Iraq) on 3 December 1924. RAF squadrons quelled rebellions while carrying out the role of imperial policing

Opposite-bottom-left: Handley Page v 1500 four-engine bomber, which completed a non-stop, round-Britain flight in August 1919. Ready, but did not fly operationally, in November 1918

Opposite-top: Stanley Baldwin (1867-1947), three times prime minister and then a senior cabinet minister, on 10 November 1932 declared, "the bomber will always get through." In 1937 he was created Earl Baldwin of Bewdley



IMPERIAL POLICING

After the First World War, Britain held the League of Nations mandate to administer Mesopotamia. Tribal violence affected much of the region and almost 100,000 British regular and Indian troops were deployed there in 1921-22 at a cost of nearly £23 million. Winston Churchill, Secretary of State for War and Air, therefore agreed to a plan advanced by Air Marshal Sir Hugh Trenchard (Chief of the Air Staff) for aircraft rather than troops to maintain law and order, a policy known as "imperial policing". This reduced the cost to £8 million 1922-23 and to £4 million by 1927. It also allowed Trenchard, by demonstrating this unique contribution to imperial defence, to fend off renewed attempts by the Army and Royal Navy to break up the RAF and regain their First World War air arms (the RFC and RNAS). Squadron Leader A.T. Harris made his No. 45 Squadron into "the most useful bombers in the country" and pioneered a system whereby holes were cut in the fuselage of Vickers Vernons so that bomb-aimers could "release their bombs from a prone position." Harris's two flight commanders, Flight Lieutenant the Hon. R.A. Cochrane and Flight Lieutenant R.H.M.S. Saundby, would 20 years later be closely involved in Operation Chastise.

ACHILLES' HEEL 1938–1939

Identifying the weak spot of industrial Germany became key in planning for possible hostilities

In 1937, the RAF drew up 13 Western Air (WA) plans for implementation in the event of hostilities with Germany. WA 5 required Bomber Command “to attack the German War Industry including the supply of oil with priority to that in the Ruhr, Rhineland and Saar.”

Bomber Command identified 45 power and coking plants in the Ruhr as decisive targets. An Air Targets committee then declared that the breaching of just two Ruhr dams, the Möhne and Sorpe, would achieve the same result. Water in their adjacent reservoirs was integral to industrial processes like steel-making and the generation of hydro-electricity. Flooding would also occur “in the low-lying Ruhr valley ... (where) railways, important bridges, pumping stations and industrial chemical plants would be destroyed or rendered inoperative.”

Investigations into the construction of the dams and means of their destruction were rapidly undertaken. The Möhne comprised a triangular, concrete structure essentially kept in place by gravity. Accuracy posed a major problem, though; an error of 102–113 yards (93–103 metres) was anticipated if a “normal” 500lb (225kg) or 1,000lb (450kg) high-explosive (HE) bomb were dropped from 10–15,000 feet (3–4,500 metres). War conditions would give merely a two per cent chance of hitting the dam, assuming 750 bombs were dropped.

The same difficulty arose if a minimum of 15 500lb (225kg) semi-armour-piercing bombs were aimed at a 50-yard (45-metre) diameter area “on the lower part of the dam on the water side” to induce collapse. Even if such a tactic were feasible, “the development of a propelled piercing bomb of high capacity would be

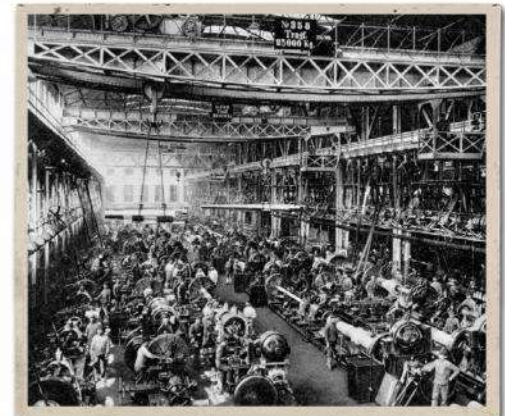


Above: Hawker Hart two-seat day bomber able to carry 520lbs (240kg) of bombs under its wings. Its maximum speed was 176mph (283kph) in level flight. The bomber entered service in 1930 and fulfilled its training role until 1943

Right: Armament production at Krupp Works in Essen in 1917. This was a prime target in the Ruhr industrial complex for British bombers during both world wars

Opposite-top: Vehicle production during the inter-war period at Krupp Works, Essen

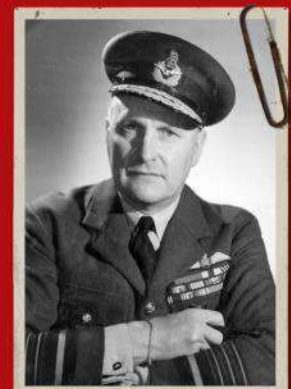
Opposite-bottom: Eder Dam, constructed 1908-1914, showing reservoir full. Note two towers used by 617 Sqn, which attacked right to left, to judge release



AIR VICE-MARSHAL SHOLTO DOUGLAS (1893–1969)

William Sholto Douglas abandoned his studies at Lincoln College Oxford in 1914 to join the Royal Field Artillery, then the Royal Flying Corps and ultimately commanded a squadron on the Western Front. He obtained a commission in the Royal Air Force and in 1938, as an air vice-marshal, was Assistant Chief of the Air Staff. On 26 July, he chaired a critical meeting of the Air Ministry's Bombing Committee, which discussed Bomber Command's conclusion that “as targets, reservoirs and dams are worth the expenditure of a considerable effort”. In opening the

proceedings, Douglas referred to these targets as the enemy's “Achilles' Heel”. After listening to a succession of experts underlining the importance of the targets and suggesting ways of breaching the dams, Douglas observed that to achieve the necessary accuracy, a low-level attack would be required, a concept that would be imbedded in future thinking. Douglas was therefore involved in the early planning process which led towards Operation Chastise, and his congratulatory message to RAF Scampton afterwards was especially significant.



essential to ensure the requisite velocity and flight approximately to the horizontal. Even then its success would be highly problematical". In all likelihood, nets would probably frustrate a torpedo attack, and an attempt to smash them with bombs in advance was thought extremely unlikely to succeed.

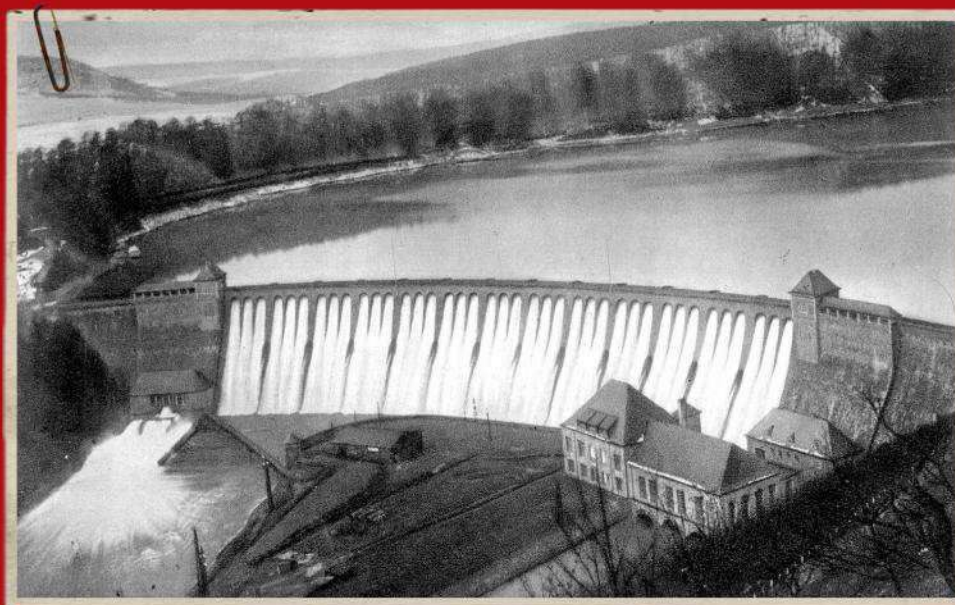
The Sorpe, with a central core supported by earth banks, presented an even greater problem. A suggestion, similar to that proposed for the Möhne, that HE bombs be dropped on top of the dam was ruled out, because of need for unattainable accuracy.

Nevertheless, on 26 July 1938, the Air Ministry insisted that attacking dams and their adjacent reservoirs – the "Achilles' heel" of Germany's industrial system – should be "treated as urgent and of pressing importance." It reiterated that breaching the dams would deprive the Germans of "the source of a large proportion of their power ... (and) the destruction of one dam may have the same result as the destruction of a considerable number of targets further down the chain of the industrial energy system." As the Möhne reservoir was the largest in the Ruhr, this made it a prime target. A propelled weapon delivered from low-level was again discussed and shelved, but general agreement reached that 40 feet (12 metres) below the crown of a gravity dam was the optimum depth for success. Without a propelled weapon to allow penetration of the dam wall, a torpedo attack, despite reservations about its effectiveness, appeared the only available option. This was all very disappointing, but



the search for a way to destroy the western German dams was certainly not abandoned. On 17 July 1939, seven dams were listed as targets by the Air Staff: Möhne, Sorpe, Ennepe, Lister and Henne in the Ruhr; and Eder and Diemel in the Weser Valley. All but the Sorpe were gravity dams. Curiously, on 29 August 1939, Justus Dillgardt (chairman of the Ruhr

Dams Association, the body responsible for them) drew attention to the vulnerability of the "large dams in southern Westphalia". If a "vast outflow" of water occurred from the Möhne, for example, "this entire industrial area would be completely paralysed ... all mines and coking plants would suddenly cease work owing to lack of industrial water supply."



"THE EDER DAM HAD NO CONNECTION WITH THE RUHR COMPLEX, BUT ITS RESERVOIR SUPPLIED WATER FOR TRANSPORT LINKS"

THE EDER DAM

The Eder Dam had no connection with the Ruhr industrial complex, but its reservoir supplied water for important transport links like the Fulda and Weser rivers, and the Mittelland Canal. Pre-war, it was listed among seven dams for attack. A gravity dam (Target Y) holding back 264 million cubic yards (202 million cubic metres) of water, it was 139 feet (42.4 metres) high, 1,309 feet (399 metres) long and 19 feet (5.8 metres) wide at the top, and 115 feet (35 metres) wide at the bottom of its triangular structure. Two towers of 781 feet (238 metres) were on top, 6.5 feet (two metres) below the crest were 39 outlets to cope with excess water and six feet (12 metres) beneath them were 12 sluices for use in an emergency. At the extremities of the wall were two power stations. The dam stood at the end of a 7.5-mile (12-kilometre) long winding valley, situated 20 miles (32 kilometres) south-west of Kassel's industrial centre and 50 miles (80 kilometres) south-east of the Möhne. Two miles (three kilometres) south of Waldeck Castle perched high above the reservoir, it nestled between high ground, roughly 1,000 feet (300 metres) on one side and 1,200 feet (370 metres) on the other. Approximately 1,100 yards (1,000 metres) in front lay a spit of land 800 feet (245 metres) high and immediately beyond it a sharp hill rose to 1,125 feet (343 metres).

PROPOSED ATTACKS 1940–1941

With the dams identified, the next stage was to work out which bombs might best serve their attack

On 3 July 1940, Air Marshal Sir Charles Portal, Air Officer Commanding-in-Chief (C-in-C) Bomber Command, reopened the issue of destroying the Möhne by proposing that “at least 12” Hampden bombers armed with torpedoes should attack at low-level. The Air Staff replied discouragingly that “an elaborate series of tests” pre-war had proved “thousands of pounds of explosives” would be required in a single detonation to destroy a gravity dam. So, “the practical difficulties of this method are considered to be insuperable at present.”

Meanwhile, on 2 May, Wing Commander C.R.F. Noyes in the Armaments Research Department at Shrewsbury had been tasked with re-examining all existing data about German dams. Three months later, without elaboration, he recorded that “a sudden demand has arisen for this operation (against the Möhne) to be carried out and a means evolved of carrying it out.” Noyes discovered a 1938 claim that 40 torpedoes, each carrying 400 lbs (180kg) of explosive, would breach the dam. Allowing an additional margin, he reasoned that 20,000 lbs (9,000kg) of explosive, if detonated 40 feet (12 metres) below the crest of the dam and exploded “at reasonably short intervals”, would bring success. To achieve this, he proposed a self-propelled weapon either to cross the surface of the reservoir in the form of a “hydroplane skimmer” or to travel beneath the surface like a torpedo. Each would weigh 3,000lbs



(1,350kg), including 2,000lbs (900kg) of explosive and would be made “to destroy its buoyancy” chambers on striking the dam wall, sink nose-first before being destroyed by standard hydrostatic fuses, “the proposed charges being Service depth charges”. Either version would need to withstand hitting the water “at 80 mph from 50ft”. A device in the form of a cup or weight would be trailed on a wire, so that the weapon could be released as the aircraft flew low over the water, at “say 20ft”. Initially, Noyes envisaged 10 Wellingtons

THE MÖHNE DAM

The Möhne Dam (Target X), the largest and most important dam associated with the Ruhr, held back 175 million cubic yards (134 million cubic metres) of water and was situated seven miles (11 kilometres) south of Soest, 26 miles (42 kilometres) east of Dortmund. It lay where the Möhne and Heve rivers converged into the reservoir and water beyond the equalising basin behind the dam flowed down a narrow valley to meet the Ruhr river at Neheim-Hüsten eight miles (13 kilometres) away. A triangular-shaped gravity dam, the Möhne was 132 feet (40.3m) high, 2,133 feet (650m) long, 112 feet (34m) wide at the base and 21 feet (6.25m) at the crest, along which a road ran. Two towers, covering access to the inspection galleries and machinery, were 639 feet (196m) apart. On the air side was a large power station, producing hydro-electricity, and a smaller one to control the flow of water through the Möhne valley. Approximately 1,640 yards (1,500m) from the dam on the water side was a tree-covered spit of land at the junction of the two rivers about 853 feet (260m) high, and the sides of the reservoir were also tree-covered and hilly. Behind the dam each side of the equalising basin, the land rose to 755 feet (230m), and immediately ahead, close to the village of Guenne, were three 20mm flak guns designed to protect the air side. On the dam wall itself, in a position to engage aircraft approaching from the water or air sides, were three more 20mm flak guns; one each on the two towers, another on a supporting buttress.





“BY SPRING 1941, NO MEANS OF DESTROYING THE GERMAN DAMS HAD BEEN FOUND, BUT MANY OF THE FEATURES LATER INCORPORATED IN THE PREPARATION AND EXECUTION OF OPERATION CHASTISE (THE DESIGNATED CODENAME FOR THE DAMS RAID) WERE NOW ON RECORD”

bombers each carrying two 3,000lb (1,350kg) missiles, one slung under each wing, so that 20,000lbs (9,000kg) of explosives would hit the dam wall at short intervals. Noyes's final report on 2 April 1941 increased the number of Wellingtons to 16 to allow for mechanical failure, aircraft losses or missing the target.

The operation would require moonlit, calm conditions and very good visibility. Attacking aircraft would now glide from 20,000 feet (6,100 metres) to 5,500 feet (1,675 metres) at right angles to the dam and release the weapons 5.5 miles (8.9 kilometres) from the target so that they struck the water half a mile (800 metres) from it. When each weapon hit the water, cordite charges would ignite to propel it towards the dam wall.

He was confident that, even if the Möhne were protected by nets and/or barges, either of his proposed weapons would break

Above: Vickers Wellington twin-engine aircraft flew 47,409 Bomber Command operations, and carried out a wide variety of other roles during the Second World War

Right: A model of the Sorpe Dam used to brief crews for Operation Chastise. The dam wall lies centre at the top of reservoir. Aircraft attacked across it from left to right

Opposite-top: A Handley Page Hampden twin-engine medium bomber with a crew four, a bomb load of 4,000lbs (1,814kg) and a speed of 265mph (427kph) at 15,500ft (4,724m). After heavy daylight losses, this aircraft undertook night bombing until 1942

Opposite-bottom: A de Havilland DH 82 Queen Bee radio-controlled drone launch attended by Winston Churchill in June 1941. One packed with explosive was considered for the attack on Möhne Dam in 1940

through. Like Portal, Noyes recommended forming a special unit of Bomber Command and concluded: “In hands with singleness of purpose and freedom from disturbance,” such a unit should in six months from the word “go” have been trained to carry out an attack, given the necessary priority.

Although Noyes's scheme had promise, the Air Staff rejected it because, travelling at 40mph (65kph), the torpedo would bounce back from the dam wall and not sink “docilely” beside it, and both weapons released so high (5,500 feet/1,675 metres) might drift off line before hitting the water.

By spring 1941, therefore, no means of destroying the German dams had been found, but many of the features later incorporated in the preparation and execution of Operation Chastise (the designated codename for the Dams Raid) were now on record.



SORPE DAM

The Sorpe (Target Z) had a different construction to all the other target dams. It comprised a central concrete core, nominally watertight, but inevitably with minor cracks, and porous, sloping supports of stone and earth on each side at a 1:2.25 incline. Unlike gravity dams, an “earth dam” such as the Sorpe could not allow excess water to wash over it and this was taken away by a sluice beside the dam. Water supplies were extracted via an intake tower upstream, so no important machinery existed at the dam itself. The Sorpe, situated at the northern end of a reservoir containing 94 million cubic yards (72 million cubic metres) of water, was 1,965 feet (600m) long and 190 feet (58m) high. Located six miles (10 kilometres) south-west of the Möhne Dam, it nestled between two hills. The western one, dominated by the village of Langscheid and a prominent church spire, was 1,115 feet (340m) high, and at the eastern end the ground rose to 1,053 feet (321m). Hence, crews were briefed to dive over the western peak, fly along the crest of the dam, drop their payload in the middle, climb over the easterly high ground and, as at all other dams, turn to port. Sir Arthur Harris considered this tactic had “a poor chance of success”, but was overruled.

ENTER WALLIS 1940

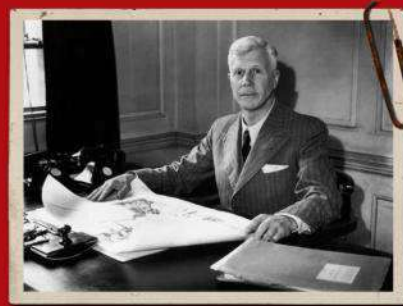
With a mind brimming full of ideas to aid the war, Barnes Wallis proved to be just the man that the Air Ministry needed

On 1 September 1939, Barnes Wallis, Assistant Chief Designer (Structures), at Vickers-Armstrong's aircraft works, Weybridge, listened to Neville Chamberlain's dramatic broadcast in his nearby Effingham home. As it ended, he mused, "What can an engineer do to end the war?"

Believing that a number of small bombs aimed at a target had little chance of success, in spring 1940 he proposed a 22,400-lb (10-ton) bomb, 19.85 feet (6.05 metres) long and 3.72 feet (1.13 metres) in diameter, which would contain seven tons of explosive and attain "the highest supersonic speeds" after release from a high level. In June, Lord Beaverbrook, the Minister of Aircraft Production pointed out that no existing aircraft could even carry the bomb. Wallis replied that he envisaged a "High Altitude Stratosphere Bomber" (dubbed "Victory") powered by six Hercules VIII engines would be able to do so. With a top speed of 330mph (531kph) and a ceiling of 40,000 feet (12,200 metres), it would be immune from enemy defences and not need defensive armament. Furthermore, the Victory bomber would carry more offensive power than a squadron of Wellingtons and be 55mph (88kph) faster than its alternative.

Impressed, Beaverbrook instructed the Ministry of Aircraft Production (MAP) to give Wallis every assistance and access to relevant documents, so he quickly became aware of the Air Ministry's interest in dams and reservoirs. In autumn 1940, the support of Vickers-Armstrong's board and the Road Research Laboratory was secured, and 1/50th models of the Möhne Dam were built at Harmondsworth and Garston, near Watford. There, a scientific officer, A.R. Collins, with a team of four, carried out scaled-down tests with two-ounce (57-gram) charges. Collins produced a series of reports for the MAP, in February 1941 concluding that "severe damage" would not occur unless the charge were exploded 150 feet (45 metres) from the dam face. On 9 January, Beaverbrook had informed Wallis "you should continue your work on your 50-ton bomber" and, despite Collins's revelation of need for a degree of accuracy not yet achieved, Wallis remained confident that his "earthquake bomb" would be decisive.

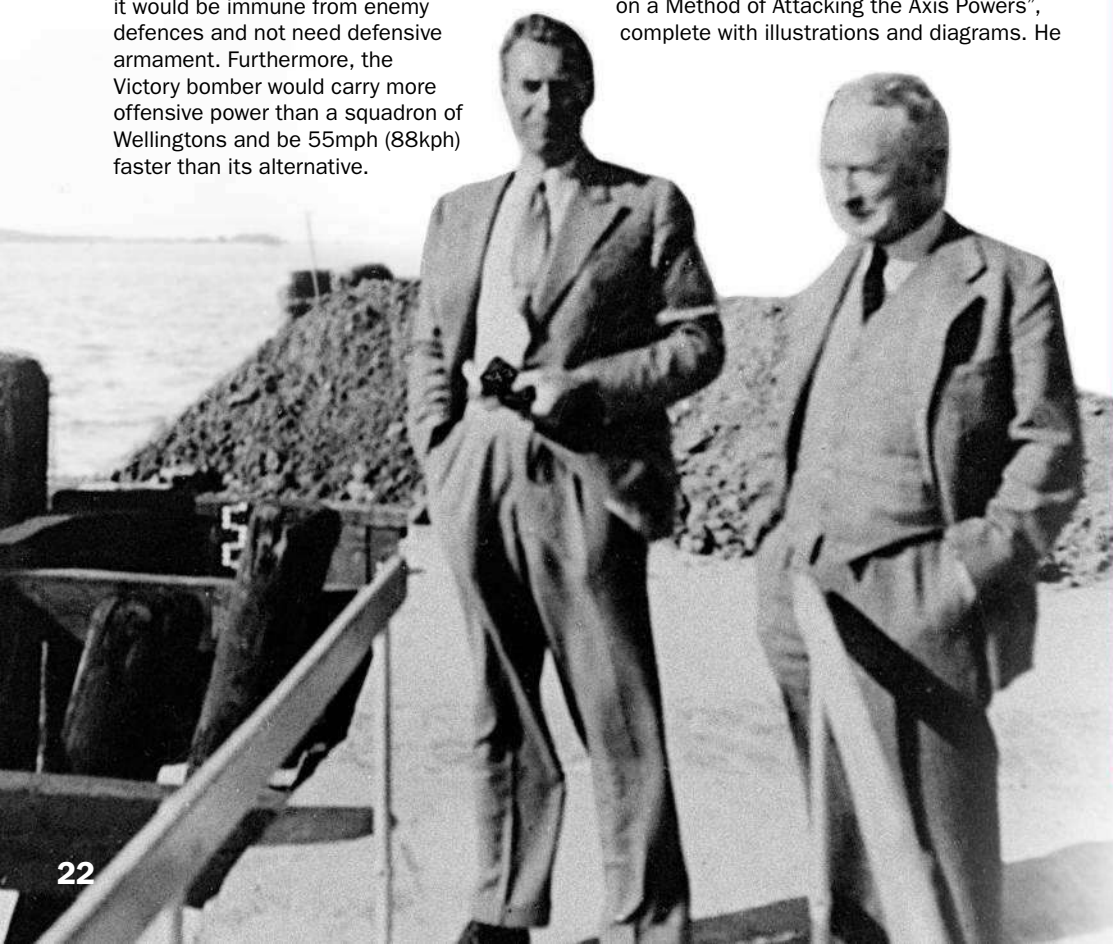
In March 1941, Wallis summarised his thoughts in a 117-page document, "A Note on a Method of Attacking the Axis Powers", complete with illustrations and diagrams. He



BARNES WALLIS (1887-1949)

Barnes Neville Wallis, the son of a doctor, was educated at Christ's Hospital and trained as a marine engineer. In 1913, he joined the Vickers Airship Department and thereafter immersed himself in aeronautics. During the First World War, he was involved in designing naval airships, becoming chief designer of the commercial R100 airship after the war. In 1930, Wallis forsook airships to join Vickers Aviation at Weybridge as Assistant Chief Designer (Structures). He made use of his experience with geodetic construction in the R100 to help the Chief Designer, Rex Pierson, design the Wellesley and Wellington bombers, and during the Second World War he became responsible for the design of the Warwick and Windsor aircraft, neither of which were hugely successful.

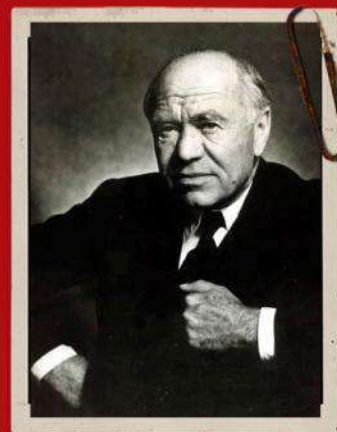
He achieved international fame, though, through his creation of the Upkeep "bouncing bomb", which prompted official support for the 12,000lb (5,500kg) Tallboy and 20,000lb (9,000kg) Grand Slam "earthquake" bombs. Post-war, he would head Vickers-Armstrong's Research and Development at Weybridge, and became involved in swing-wing aircraft and supersonic flight until his retirement in 1971. Knighted in 1968, his close association with the RAF and 617 Squadron in particular was recognised by the attendance at his 90th birthday party (in Thatcher's hotel close to his home) of Sir Arthur Harris, Sir Ralph Cochrane, and members of the wartime squadron from across the world.



LORD BEAVERBROOK (1879–1964)

William Maxwell "Max" Aitken, Baron Beaverbrook, was a Canadian businessman, who settled in Britain in 1910 and shortly afterwards was elected to Parliament. Created Baron Beaverbrook in 1917, the following year he joined the government as Minister of Information. During the inter-war years, Beaverbrook expanded his newspaper interests, raising the profile and circulation of the Sunday Express and Daily Express. His long-standing friendship with Winston Churchill took him into government again in May 1940 as Minister of Aircraft Production (MAP), in charge of a ministry comprising some departments (transferred from the Air Ministry) run by RAF officers and others led

by scientists. The Ministry exercised a wider remit than simply improving aircraft production, taking an active interest in the ways in which aircraft could be used and the weapons they might carry. Hence, in due course, the Ministry assumed overall responsibility for tests associated with the development of the "bouncing bomb". In June 1940, Barnes Wallis persuaded Beaverbrook that his 10-ton weapon deserved support and the minister not only ordered the MAP to co-operate with Wallis but to give him access to all relevant data. Unwittingly, therefore, Lord Beaverbrook had started the process which would culminate in Operation Chastise.



explained that "natural sources of power ... (were) concentrated and immovable targets" from which power stations, oil wells, gasworks and hydroelectric facilities supplied industrial needs. Factories required energy in the form of coal, oil and water from these static locations, on which hitherto the RAF's "puny efforts" had been "quite powerless to inflict any but minor and therefore reparable damage". He deplored "stick bombing ... by which range errors are covered by a wide distribution in the direction of a flight while line areas are covered as well as may be by flying over the target in two or

more different directions." The "so-called land mine" was accurate only "within several hundred yards."

Wallis had studied the effect of underground explosions, quoting data from the detonation of multiple mines beneath the surface of the Messines Ridge in 1917. He proposed that the 10-ton bomb be released at high level from a Victory bomber to land close to a target, burrow beneath it at an angle, explode underground and cause it to collapse. Petrol and oil storage tanks, shafts and galleries of coal mines, and oil refineries were suitable targets. So were docks, docks gates, canals, locks and aqueducts if the bomb dropped close to them. Dams, particularly those generating hydro-electricity, were especially vulnerable, and to illustrate this Wallis showed how his bomb would destroy the Möhne. Seeking to gain their support, Wallis distributed copies of "A Note" to a large number of scientific, political and military figures.

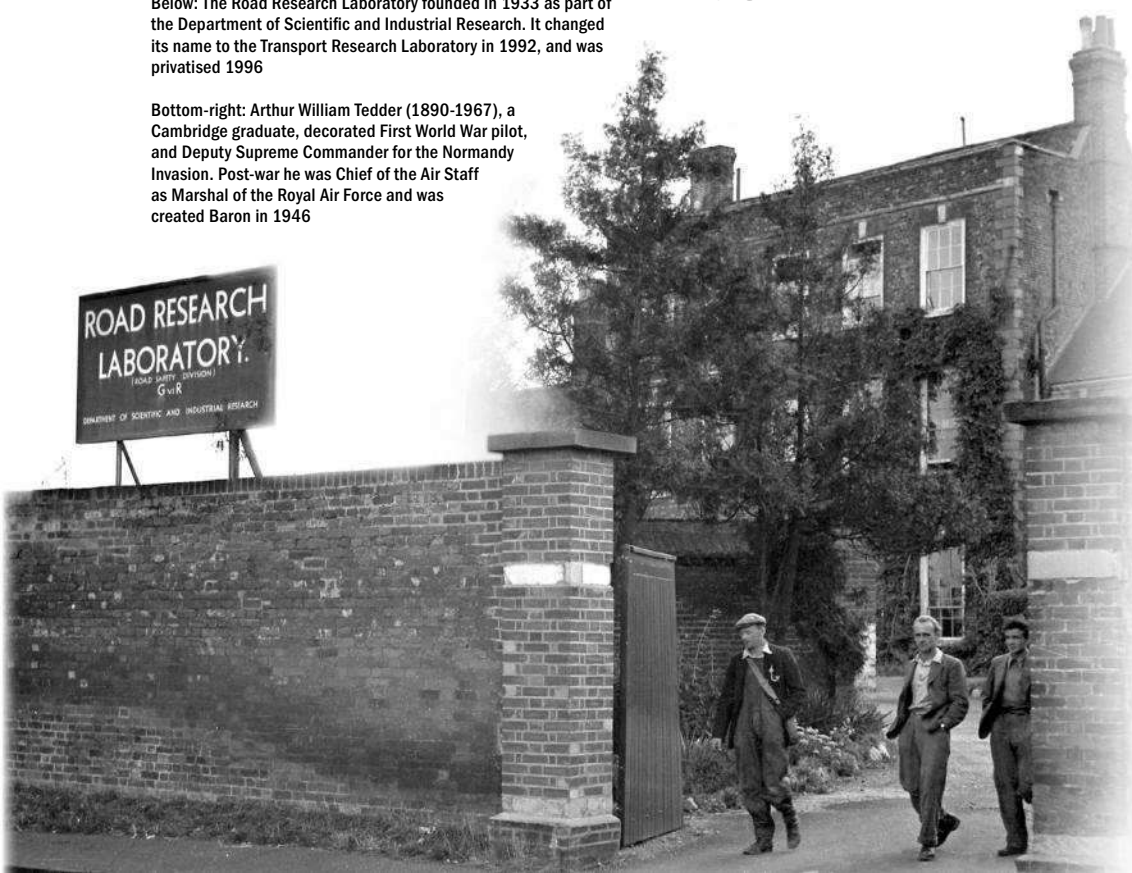


Opposite-bottom: Group Captain F.W. Winterbotham (left), head of Air Section (MI6) who gave Barnes Wallis valuable support, at a 1936 meeting with Baron de Ropp, a wartime double agent

Right: The Luftwaffe reconnaissance photo of Brooklands, near Weybridge. The camouflaged airfield (B) is between the railway line to London (centre) and the River Wey (right). Vickers Works (A) is bottom right

Below: The Road Research Laboratory founded in 1933 as part of the Department of Scientific and Industrial Research. It changed its name to the Transport Research Laboratory in 1992, and was privatised 1996

Bottom-right: Arthur William Tedder (1890-1967), a Cambridge graduate, decorated First World War pilot, and Deputy Supreme Commander for the Normandy Invasion. Post-war he was Chief of the Air Staff as Marshal of the Royal Air Force and was created Baron in 1946



TARGET MÖHNE

With the main target finally agreed upon, tests began to work out the best plan of attack – but experiments proved disappointing...

Rapid official reaction was prompted by “A Note”, particularly as it highlighted the Möhne Dam. An Aerial Attack on Dams (AAD) committee under Dr D.R. Pye was created in order to advise on methods of breaching the dams.

Pye opened the first meeting on 10 March 1941 by claiming “that the work on the possibilities of aerial attack on dams had been started at the instigation of Mr Wallis.” R.S. Capon, a MAP representative, disagreed and reminded the Committee that the prospect of attacking dams had been under discussion “for a number of years”. Nor was Wallis’s idea the only one before the Committee: the Ministry of Home Security had suggested dropping a mine attached to a float close to the dam so that it would sink and be dragged to the target by the natural flow of water over the spillway. After Wallis had outlined his scheme, further experiments under the overall control of the MAP were agreed, but, for security reasons, all reference to the Möhne Dam was omitted from written records.

Encouragingly, in April a quite separate meeting convened to discuss the validity of Wallis’s method against underground storage tanks and declared it “not unreasonable”. But a month later, Wallis learnt that the Air Staff had decided both the Victory bomber and 10-ton bomb were impracticable in the short-term. Nevertheless, experiments connected with destroying the dams would continue.

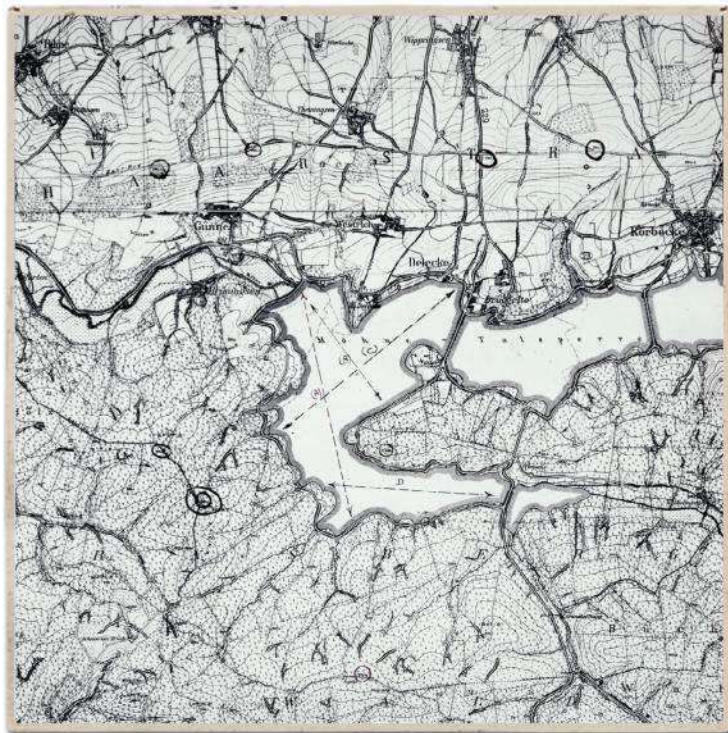
Already, because the need to secure intermediate data between two-ounce charges and the final weapon had been recognised, use of a disused dam, the Nant-y-Gro near Rhayader in Wales, had been acquired from the Birmingham Water Company. No experiments on the model dam at Garston took place after

January 1941, but 1/50th scale models of the Möhne remained at the RRL site in Harmondsworth. The Welsh dam, although straight rather than curved like the Möhne, was 1/5th the size of the target dam, so 1/10th models of it were constructed at Harmondsworth alongside a replica of the adjacent lake. Experiments took place against both sets of models (Möhne and Nant-y-Gro), with the results being monitored by the AAD committee and summarised in reports to the MAP by the scientist A.R. Collins. Different types of explosives were tried, but at best the depressing conclusion was that “a charge of 15,000lbs detonated 100feet away from the face of the dam would cause severe damage but not complete failure.” Collins frustratedly wrote that the overall situation “was still complex and unhelpful”.

Wallis remained optimistic, buoyed by the Committee’s rejection of the Ministry of Home Security’s proposal. At its third meeting on 10 December 1941, although it agreed to more tests, the AAD Committee reviewed several old proposals. Capon maintained, for example,

that dropping a number of small bombs in a stick offered “greater statistical probability of a direct hit” than any other method, by implication including Wallis’s.

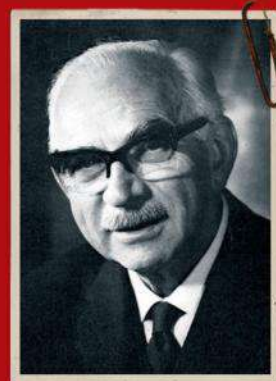
Explosion of scaled charges at varying distances from the various Harmondsworth models continued, but still without success. Wallis and his wife were among a small group to witness more substantial tests against the Nant-y-Gro dam. The outcome was discouraging. Despite a great upsurge of water, when charges were detonated at a distance from it, the dam wall held. Collins therefore

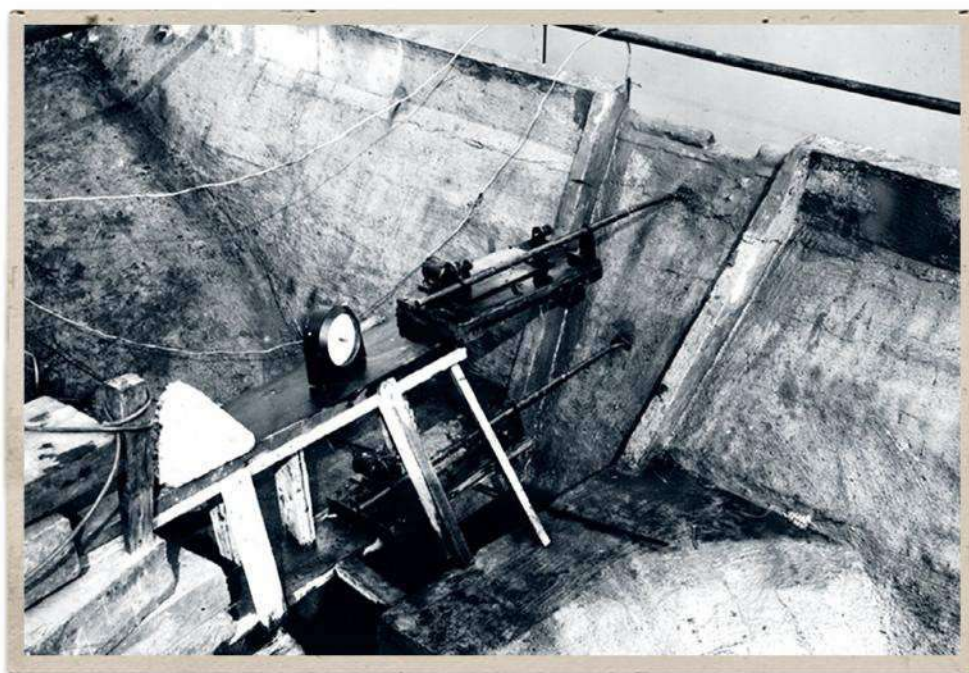


DR W. H. GLANVILLE (1900–76)

William Henry Glanville achieved first class honours in civil engineering at East London College (now Queen Mary’s) in 1922, and subsequently obtained a PhD and DSc. After graduating, he joined the Building Research Station at East Acton, going with it to Garston in 1925. Eleven years later, Glanville transferred to the Road Research Laboratory at Harmondsworth as deputy director, becoming its director in 1939. Glanville was directly associated with Barnes Wallis’s big bomb concept from Autumn 1940, first agreeing to model tests at Harmondsworth, and then supporting

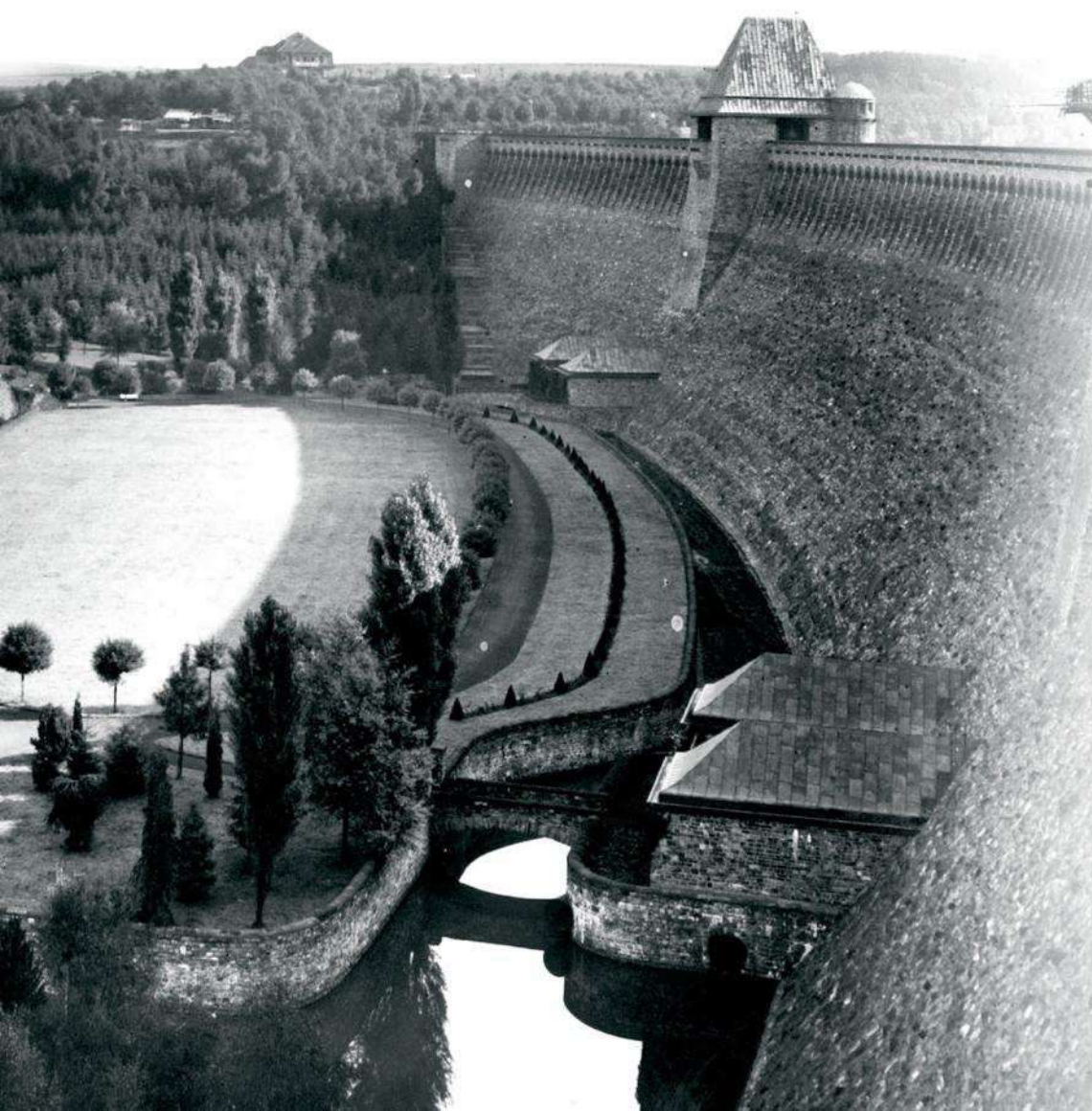
those at Garston. He was also a member of the Air Attack on Dams Committee set up to monitor the progress of Wallis’s work. At an Air Ministry meeting on 5 May, Glanville pressed successfully for additional aerial reconnaissance to establish water levels at the dams, and after the raid he arranged further experiments towards possible use of Upkeep against “highly curved” Italian dams for which no data existed. He was President of the Institution of Civil Engineers 1950–51 and was knighted in 1960. Glanville retired as Director of the RRL in 1965.





Above: A model of the Nant-y-Gro dam model at the Road Research Laboratory, showing instruments to measure the impact of explosions

Below: The power station surrounded by ornamental gardens below the Möhne Dam. Two of the three flak guns would be placed on the tower and buttress to its left



Opposite-top: Map of the Möhne Reservoir. Lancasters dived over the Koerbecke bridge on the top stretch of water (right), flew right to left across the spit of land opposite – Delecke – and attacked the dam below Guenne

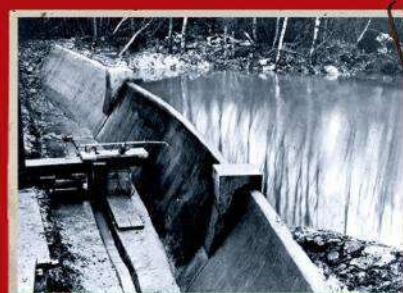
concluded it “unlikely” that a single charge of less than 30,000 lbs (13 tons) would destroy a gravity dam like the Möhne, if exploded at a distance from it. Inability to gain greater accuracy effectively undermined the whole concept of the 10-ton bomb going through the water of the reservoir to penetrate the ground beneath a target.

The high hopes of “A Note” now appeared completely unrealistic, and Wallis looked far from devising a weapon to destroy the Möhne, or indeed any other dam.

“EXPLOSION OF SCALED CHARGES AT VARYING DISTANCES FROM THE HARMONDSWORTH MODELS CONTINUED, BUT STILL WITHOUT SUCCESS”

THE GARSTON MODEL

The earliest 1/50th scale models of the Möhne Dam were built at the Road Research Laboratory, Harmondsworth, during the third quarter of 1940, with “preliminary tests” being reported in November. “A more carefully prepared model” was then planned at the Building Research Station (BRS) at Garston, near Watford, and constructed between 25 November 1940 and 21 January 1941. Dr Norman Davey, Head of Structural Development, and A.J. Newman, Head of the Concrete Section, designed and built the model, which was 42 feet (12.8 metres) long, three feet (0.9 metres) high and two feet (0.6 m) wide at the base with 15 feet (4.6 metres) between the mock towers. Situated among trees below the main office complex, the model dam blocked a small stream which acted as the Möhne reservoir. As at Harmondsworth, tests were conducted by a four-man team led by the RRL scientist A.R. Collins. Charges of two ounces (57g) were exploded one to three feet (0.3-0.9 metres) from the dam wall on 10 separate occasions, Collins being responsible for the detonations, while another scientific officer, G. Charlesworth, measured their effect. Collins recorded that the wall was cracked but not broken from the tests, and experimental work soon returned to Harmondsworth.



BOMBER COMMAND AT WAR 1939–1942

Upon entering the war, it became painfully clear that the British planes were no match for the powerful Messerschmitts

Bomber Command had gone to war believing that bomber formations flying in daylight, mutually protected by defensive fire against fighters, could locate and destroy individual targets.

The twin-engine Whitley, Wellington and Blenheim monoplane bombers were undoubtedly superior to the open-cockpit biplanes of 1938. On 4 September, 29 Blenheims and Wellingtons set out for the naval base of Brunsbüttel on the Kiel Canal and warships anchored nearby. Hampered by bad weather, few aircraft found the targets and even fewer recorded hits, which caused no discernible damage. Seven bombers were lost. The Air Ministry laconically recorded: "With this the war began."

Despite further indifferent results, the pre-war dream persisted – until 24 Wellingtons took off for the naval base at Wilhelmshaven on 18 December 1939. Two turned back, and only 10 of the remaining 22 survived,

several of those returning badly damaged. The Germans reported that despite "a tightly closed formation", faster single-engine Messerschmitt Bf 109 and twin-engine Bf 110 fighters had savaged the attackers.

Further heavy losses among single-engine Battles carrying out reconnaissance flights from eastern France, and navigational and operational problems experienced by Whitleys dropping leaflets over Germany persuaded the C-in-C Bomber Command that the planned daylight campaign against German industry could not be mounted. It had become clear that the bomber would not always get through and night bombing now became a serious consideration for the team.

The night after the Germans invaded the Low Countries and France on 10 May 1940, 37 Whitleys and Hampdens attacked communication targets at Moenchengladbach. On 20 May, the Air Ministry declared factories connected with aircraft production primary targets; oil plants and stocks were also to be bombed. However, rudimentary navigational aids and severe weather conditions combined to affect the crews' ability to reach their designated target. Over the next 14 months, the failure to achieve pinpoint accuracy became even clearer.

On 7 July 1941, a directive acknowledged Bomber Command's limitations. Although the "vital nature of the Ruhr-Rhineland industries" must be "borne in mind", "the main effort of the bomber force" should aim at "destroying the morale of the civil population as a whole and of the industrial workers in particular." A

THE WHITLEY BOMBER

Towards the end of the 1930s, twin engine monoplane bombers with enclosed cockpits, multiple machine-guns and internal bomb-bays came into service, encouraging a belief that the bomber could strike decisively at German industry. The Armstrong Whitworth Whitley was one of a new quartet, which included the Bristol Blenheim, Handley Page Hampden and Vickers Wellington. Powered by two 1,145hp Merlin X engines, with a crew of five, the Whitley was armed with six machine-guns, had an operational range of 1,500 miles (2,400 kilometres), a ceiling of 26,000 feet (7,900 metres) and a top speed of 230 mph (370 kph) at 17,000 feet (5,200 metres). 70 feet 6 inches (21.5 metres) long, with a wing-span of 84 feet (25.5 metres) it carried a bomb load of 7,373lbs (3,344kg). Once war was declared and before fighting had broken out in the west, Whitleys dropped leaflets on Germany urging the population not to support aggressive action, and later executed raids over Germany, until withdrawn from bombing operations in 1942. Navigator Gerald Dickson, who doubled as a bomb-aimer in the aircraft, doubted whether it actually ever reached, let alone exceeded, 200mph (230kph) and believed it had "no prayer in a contest with a lurking Messerschmitt." Although the Whitley could not hope to fulfill the destructive dreams of pre-war theorists, it did help to launch the bombing campaign against Germany.



Above: The Bristol Blenheim being serviced in June 1940. Armourers load 250lb (113kg) bombs and incendiaries, while other ground staff refuel the aircraft and attend to the engines and cockpit

Below: A Fairey Battle single-engine bomber at Reims-Champagne airfield in France during the Phoney War in January 1940. Armourers load 250lb (113kg) bombs in the snow





month later, an analysis of raid photographs revealed that only one in four aircraft which reported attacking their target in Germany actually got within five miles (eight kilometres), or an area of 75 square miles (195 square kilometres), of it. In the industrial Ruhr in good weather, the figure was one in 10 and in poor conditions one in 15.

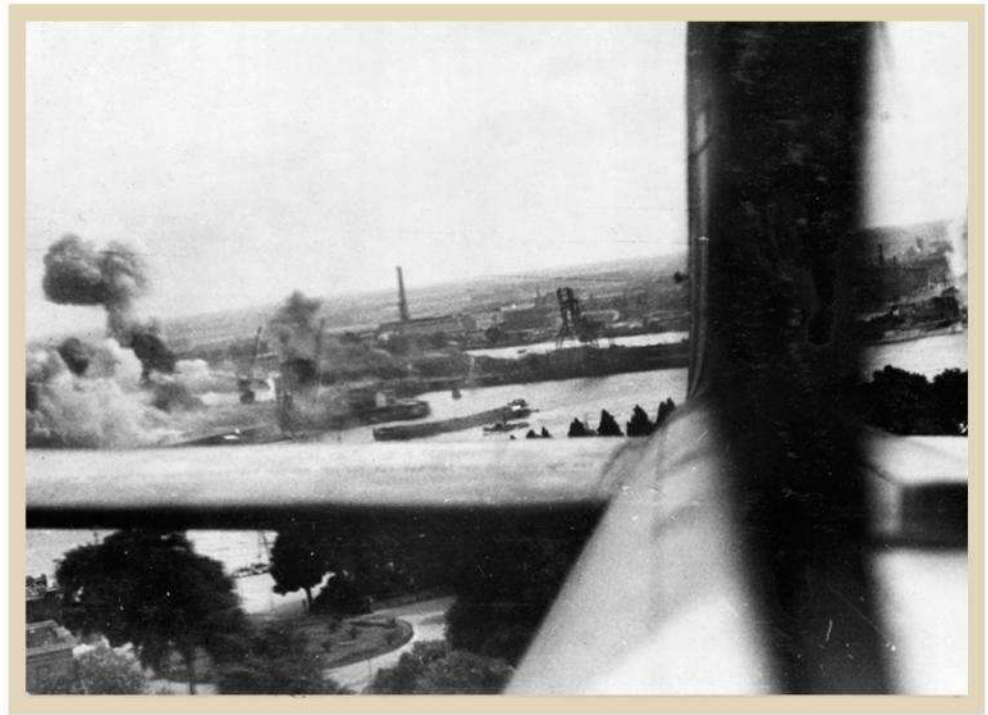
1942 brought scant improvement. In January, a raid on Wilhelmshaven by 124 aircraft, which was declared “good”, in reality caused “light damage” and just six casualties due to a wide scattering of bombs. Later that month, of 83 bombers sent to Bremen just eight even claimed to have hit the primary target. On 15 February, precisely a week before Air Marshal A.T. Harris took over Bomber Command, the CAS declared, “the aiming points are to be the built-up areas, not, for instance, the dockyards or factories.”

Stirling, Halifax and Lancaster four-engine bombers were now operational and able to mount heavy raids on German cities aided by a new navigational aid – Gee (Ground Electronic Engineering), and the Pathfinder Force. During 1942, yet more navigational aids like the Oboe blind-bombing device came into service, but still with an average error of 120 yards (110 metres). As RAF planners strove for a means to destroy the German dams, the reality was that Bomber Command had long abandoned hope of eliminating specific targets and adopted a policy of “area bombing” – hence the official scepticism about Wallis’s proposal.

“BOMBER COMMAND HAD LONG ABANDONED HOPE OF ELIMINATING SPECIFIC TARGETS”

Above: An Avro Lancaster silhouetted against flares, smoke and explosions during a night raid over Germany. Future Dambuster pilot Flt Lt D.J. Shannon took this photo

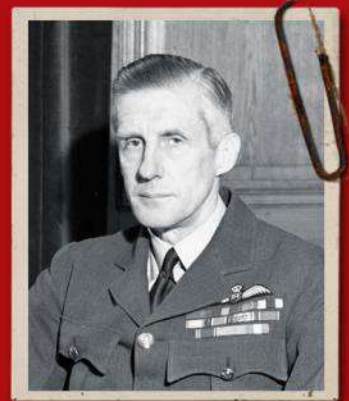
Below: A daylight raid by No 2 Group Blenheims on Rotterdam docks on 16 July 1941



AIR CHIEF MARSHAL SIR EDGAR LUDLOW-HEWITT (1886–1973)

During the First World War, Edgar Rainey Ludlow-Hewitt served with distinction in the Royal Flying Corps on the Western Front, rising to brigadier-general by the Armistice. During the inter-war years, he commanded the RAF Staff College at Andover, was successively Air Officer Commanding (AOC) Iraq and India and was appointed KCB in 1933. He became Air Officer Commanding-in-Chief (AOC-in-C) Bomber Command in 1937. Ludlow-Hewitt was at High Wycombe, when Bomber Command planned to neutralise the Ruhr industry by attacking 45 specific targets in flying 3,000 sorties over a fortnight, while accepting

a loss of 176 bombers. This led to the alternative proposal to hit the Möhne and Sorpe dams, and on 28 July 1938 in listing electricity power stations in Germany as priority targets, he wrote: “I have not included reservoirs in this plan, as I understand that the feasibility of attacking this form of objective is still under consideration.” In April 1940, Ludlow-Hewitt gave way to Air Marshal Sir Charles Portal, who would soon vainly press for a Hampden torpedo attack on the Möhne Dam. From 1940, Ludlow-Hewitt served as Inspector-General of the RAF, retiring in November 1945.



Regd. Post.

TELEGRAMS: "VICASTRONG WEYBRIDGE"
TELEPHONE: BYFLEET 240 (12 LINES)



REGISTERED OFFICE: VICKERS HOUSE,
BROADWAY, WESTMINSTER, S.W.1.

Vickers-Armstrongs Limited.

(AIRCRAFT SECTION)

STRICTLY
CONFIDENTIAL.

WEYBRIDGE WORKS,
WEYBRIDGE, SURREY.

OUR REF. CA.

YOUR REF.

ENC.

21st April 1941.

Major Oliver Stewart,
"Aeronautics"
Tower House,
SOUTHAMPTON STREET, W.C.2.

My dear Stewart,,

I have long been wanting to have a talk with you over the various methods of development as regards air warfare which have appeared from time to time in your most interesting paper, and for the last eight months I have been working very hard on a method which is described in the accompanying Note.

While the whole of the information is naturally ~~secret~~ I feel that influential people such as yourself should have an opportunity of seeing such things, particularly as I know that you are on the opposite side, and I should be most grateful if you could find time to read my paper and let me have any criticisms that occur to you.

I may say that having been put through the 'third degree' by a strong committee of scientists I am pleased to learn that as far as the use of the big bomb is concerned, I appear to have carried conviction.

With kind regards,
Yours sincerely,

Bruce Wallis

ITEM 03

**LETTER FROM BARNES WALLIS TO
MAJOR OLIVER STEWART
21 APRIL 1941**

This letter relates to Barnes Wallis's plan for a 10-ton bomb dropped from high level as described in 'A Note on a Method of Attacking the Axis Powers', a copy of which was enclosed. Editor of *Aeronautics* magazine and a decorated First World War pilot, Stewart also wrote for *The Observer* and *Evening Standard* newspapers. Aware of Service and scientific reservations, Wallis was effectively seeking Stewart's influential support. The alleged "third degree" treatment referred either to the first meeting of the Air Attack on Dams committee on 10 March 1941 or what Wallis termed "the Tizard Committee" on 11 April.

Experience is as to INTENSITY and not as to duration.

Thomas Hardy.

A NOTE ON A METHOD OF ATTACKING
THE AXIS POWERS.

A X I O M S.

1. MODERN WARFARE IS ENTIRELY DEPENDANT UPON
INDUSTRY.
2. INDUSTRY IS DEPENDANT UPON ADEQUATE SUPPLIES
OF POWER.
3. POWER IS DEPENDANT UPON THE AVAILABILITY
OF NATURAL STORES OF ENERGY SUCH AS
COAL, OIL, & WATER (WHITE COAL).

ITEM 04

**A NOTE ON A METHOD OF
ATTACKING THE AXIS
POWERS**

Extracts from Wallis's first scheme contained in A Note on a Method of Attacking the Axis Powers, completed in March 1941. This 117-page document included extensive illustrations (some of which can be seen here), and explained Barnes Wallis's idea for a 10-ton bomb released at 40,000 feet (12,000 metres) from a six-engine Victory bomber against ground or water-related targets. He argued that striking "surface targets" like factories with "relatively small bombs" was hopeless. A large, deep-penetration bomb burrowing beneath the sources of power, like coal-mines, oil storage tanks and reservoirs, would have a much more decisive impact. The Möhne Dam provided an example of its performance against a large dam.

-----000-----

S U M M A R Y.

1. The Bomb Armament of all the belligerent Air Forces in this War consists of relatively small bombs designed to attack surface targets such as factories and houses.
2. This form of attack is effectively countered by Dispersal. It is becoming impossible to destroy simultaneously all the factories and all the generating stations all over the Continent of Europe.
3. All these factories are however dependant upon relatively few and highly localised Stores of Energy in the form of Coal, Oil and Water Power; air attacks on this country are dependant upon large Stores of Petrol buried in tanks many feet underground.
4. These Stores of Energy are so concentrated and so massive that they cannot be dispersed, but also they are invulnerable to the present type of Bomb Armament.
5. This paper shows that :-
 1. These Stores of Energy are vulnerable to very large bombs.
 2. By sterilising their Stores of Energy the Industries of Germany and Italy can be quickly paralysed.
 3. The very large bomb and appropriate bomb carrying aircraft are practicable and can be produced in this country.

F O R E W O R D.

This brief conspectus of an immense subject must inevitably exhibit the defects inherent in the work of a jack-of-all-trades, for its composition involves some knowledge of such a wide variety of subjects as air strategy, ballistics, modern explosives, steel technology, naval and military mining, meteorology and optics, the storage and generation of power, aerodynamics, and the design and construction of large bomber aircraft.

The author is solely responsible for the proposals and the conclusions which are set out in this paper but must acknowledge his deep indebtedness to the many masters of each trade who have so generously placed their expert knowledge at his disposal and with whom he has had the privilege of discussing various aspects of the problem.

Criticism will naturally be forthcoming but the author has had the courage to proceed in the sincere belief that in such a complex matter it is the aircraft designer who must set the pace.

That the really big bomb, when used against the targets and in the manner described hereunder, is the answer to the terrible stalemate of modern warfare is certainly true; the bigger the better, but the biggest of bombs is useless without an aircraft to carry it. The sequence of development has therefore been to determine firstly the maximum size of bomber aircraft that can be built quickly without risk of failure; and then to determine the properties and performance of the largest bomb that such an aircraft will carry.

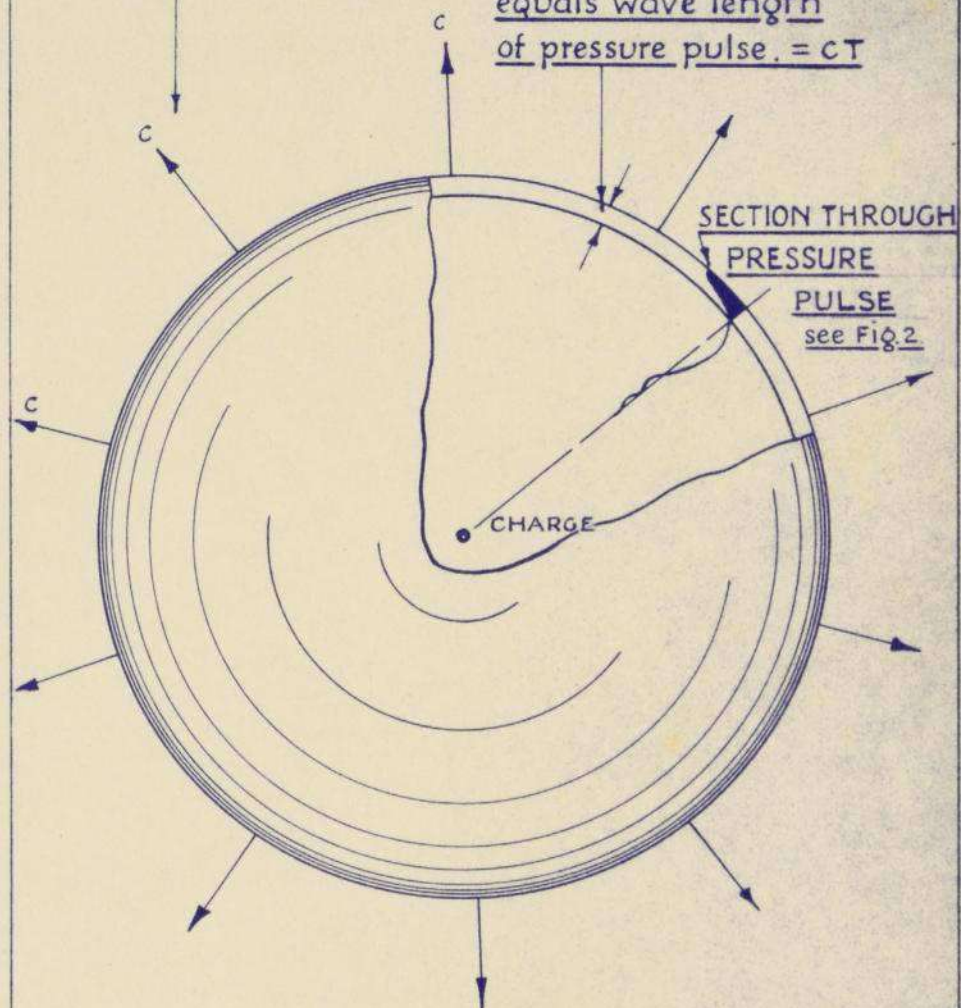
While stressing that the conclusions reached are entirely his own, the author is deeply grateful to Sir Charles Craven, R.N. and Alex. Dunbar Esq. for their kind permission to undertake this work; and to R. K. Pierson Esq., F.R.Ae.S., for his constant encouragement and collaboration, and to the many members of the staff of the Aviation Section of Messrs Vickers-Armstrongs without whose enthusiastic help this task could not have been completed.

B.N.W.

WEYBRIDGE
July 1940 - March 1941.

Velocity of expansion is that of a
compression wave in the transmitting medium.

Thickness of shell
equals wave length
of pressure pulse. = CT



DIAGRAMMATIC REPRESENTATION OF
PRESSURE PULSE MOVING OUTWARDS IN THE
FORM OF AN EXPANDING SPHERICAL SHELL

FIG. 1.

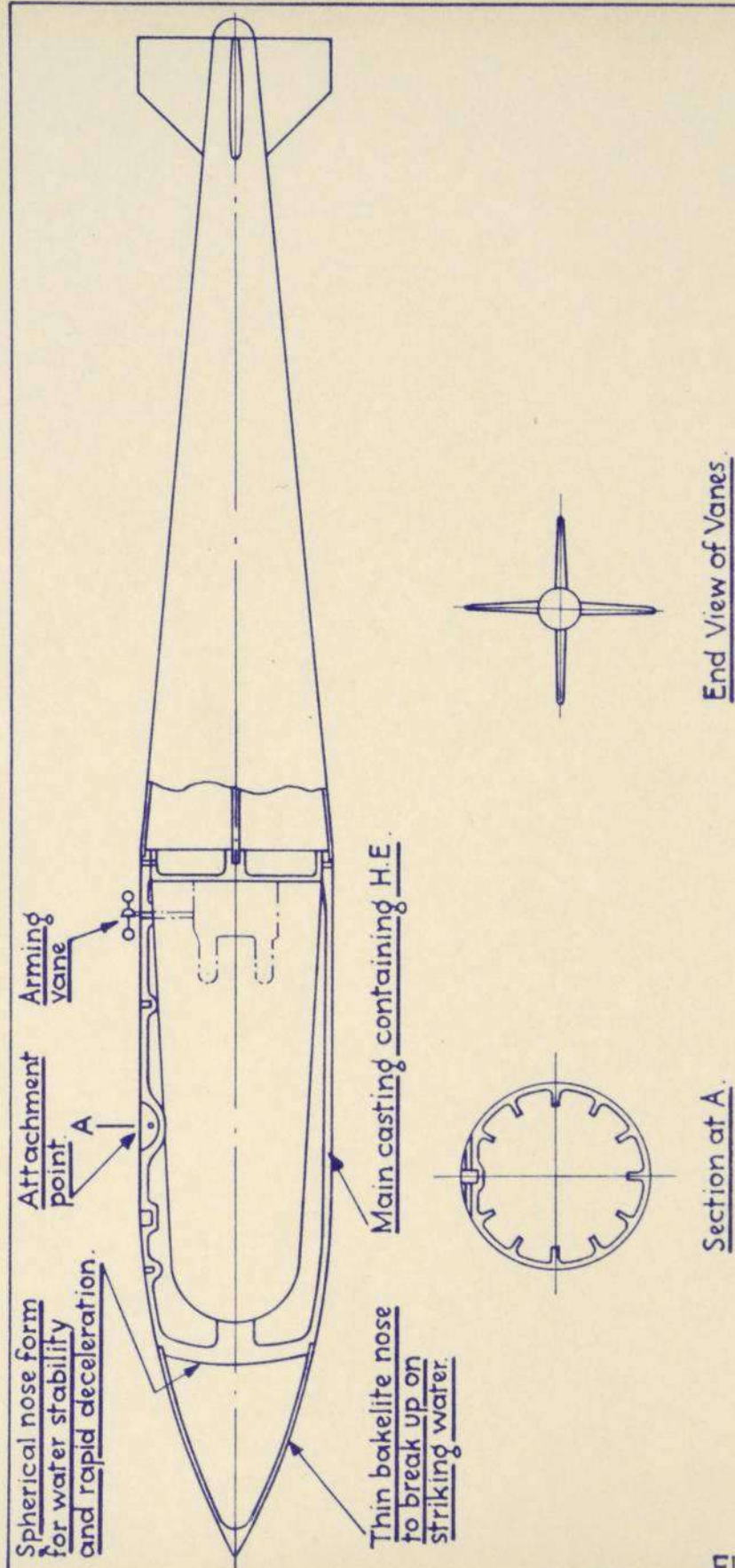
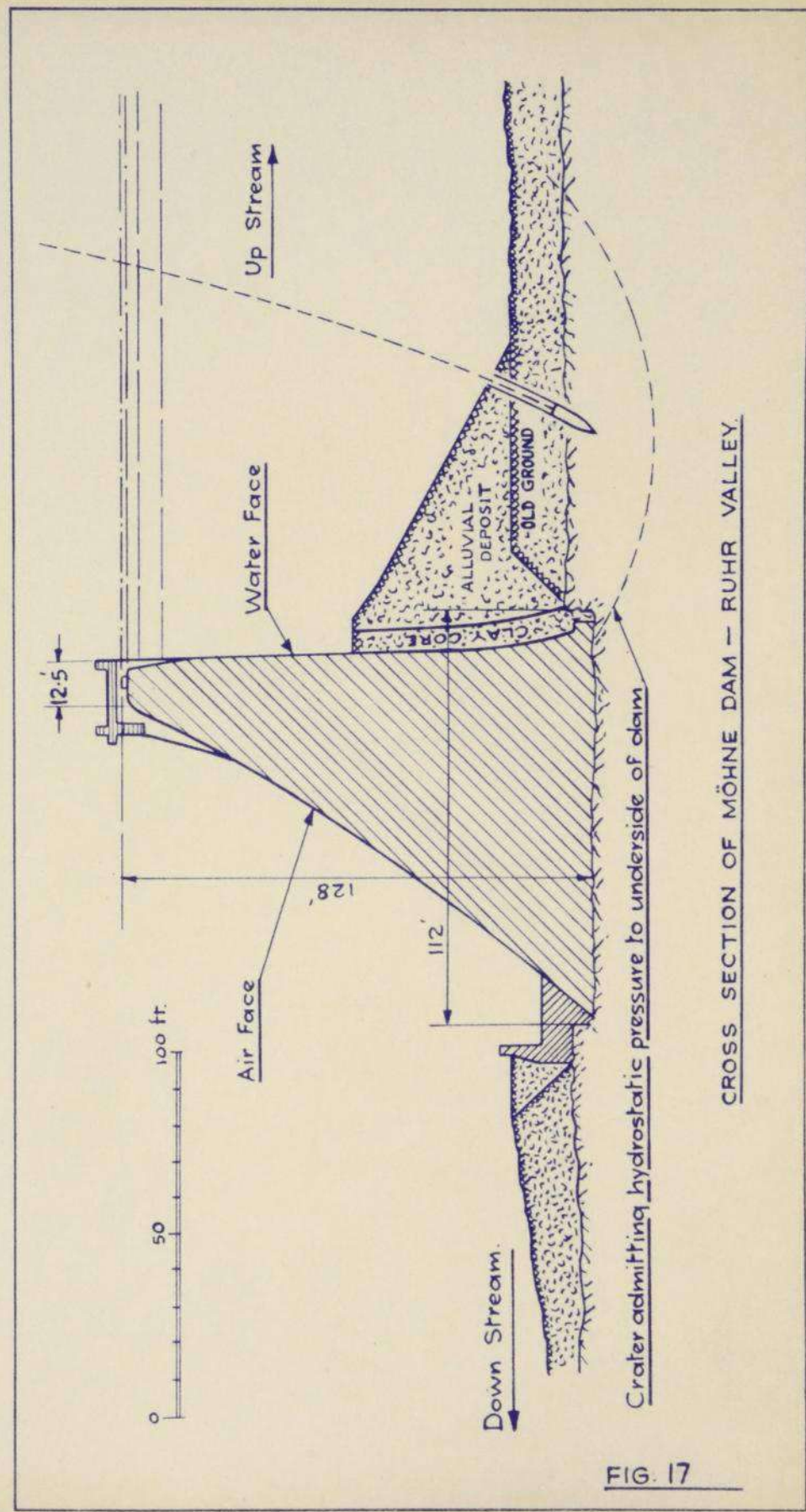
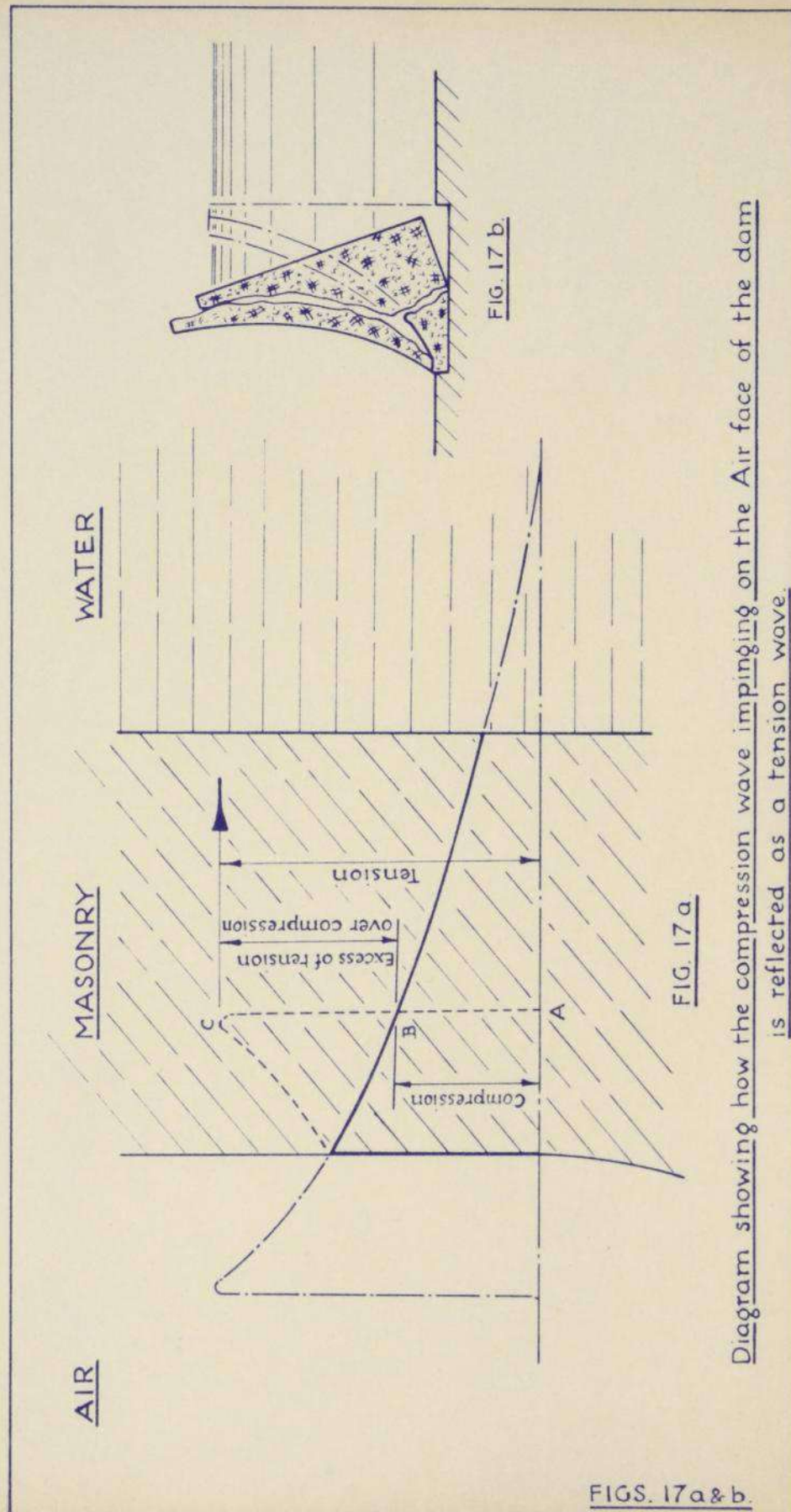


FIG: 8



CROSS SECTION OF MÖHNE DAM — RUHR VALLEY

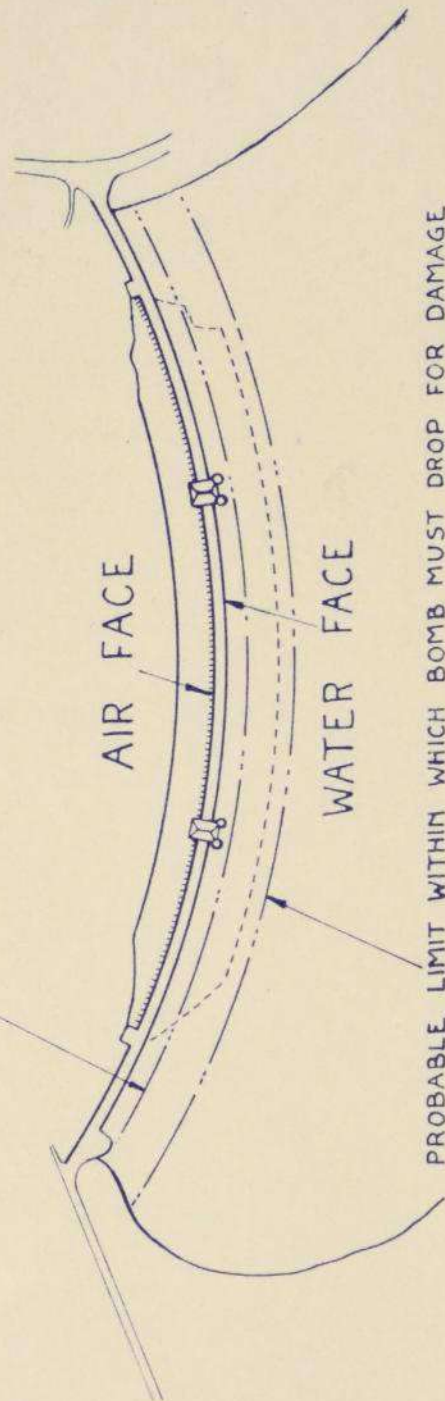
FIG. 17



FIGS. 17a & b.

Diagram showing how the compression wave impinging on the Air face of the dam
is reflected as a tension wave.

PROBABLE LIMIT WITHIN WHICH BOMB MUST DROP FOR DESTRUCTION



PROBABLE LIMIT WITHIN WHICH BOMB MUST DROP FOR DAMAGE

MÖHNE DAM - DIAGRAM SHOWING TARGET AREAS
SCALE - 1" = 330'

FIG. 19

GENESIS OF THE “BOUNCING BOMB”

1940–1941

While experiments at Harmondsworth continued with no luck, Wallis devised an entirely new approach

Thirty years after the event, Barnes Wallis wrote to the RRL scientist A.R. Collins: “The bouncing bomb was originated (invented) solely to meet the requirement so convincingly demonstrated by your experiments that actual contact with the masonry of the dam was essential.”

The prospect of destroying the Möhne with a contact explosion had been discussed in July 1941. After meeting RRL staff at Harmondsworth, R.S. Capon from the MAP and a member of the AAD Committee wrote: “It is recommended that further consideration be given to attack on gravity dams by bombs designed for operation in contact with the face.” Three months later, the Secretary of the AAD Committee mentioned the possibility of contact tests to Capon, but none took place. On 3 February 1942, Capon returned to the question of exploding a bomb in contact with a dam wall.

That month, Collins used a two-ounce (57-gram) charge against a model of the Nant-y-Gro dam and convincingly breached it. Wallis now

concentrated on “determining the smallest possible charge that would breach the dam when detonated in actual contact with the masonry”, and the weapon that could deliver it. Later, he recalled, “I had the idea of a missile, which if dropped on the water a considerable distance upstream of the dam would reach the dam in a series of ricochets.”

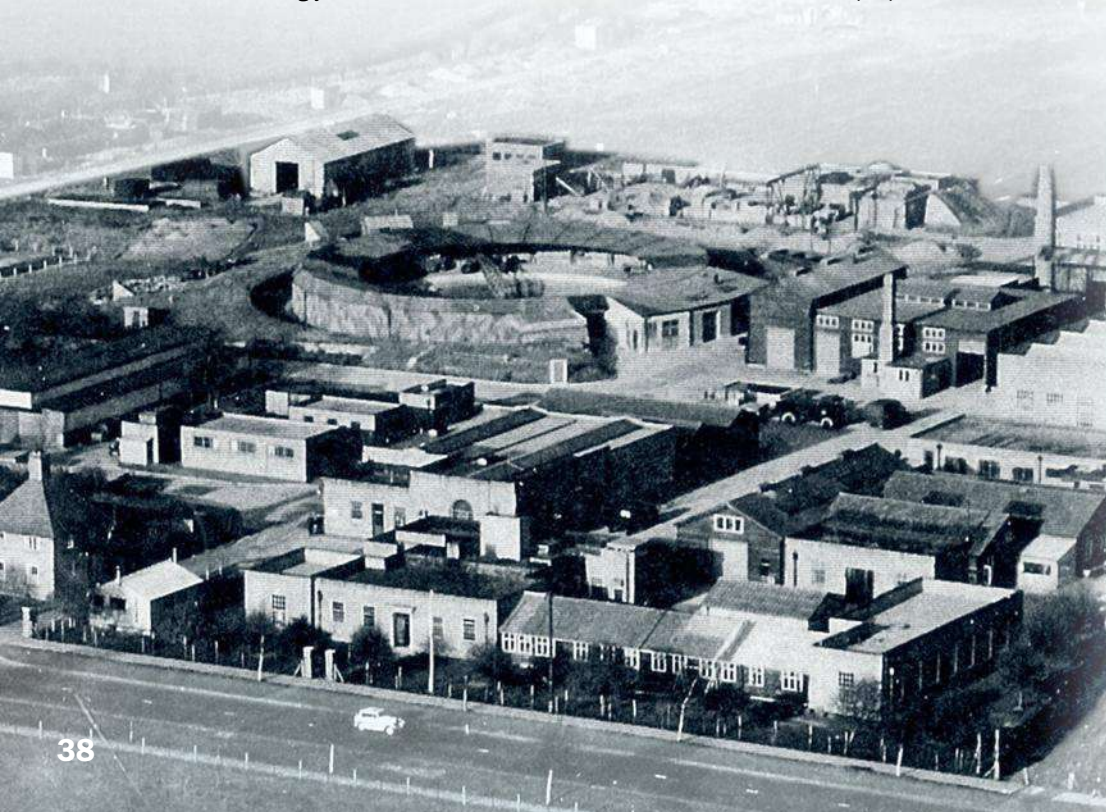
As Collins continued experimenting on models at Harmondsworth, in April Wallis commandeered a supply of his younger daughter’s marbles at his Effingham home to fire them from a raised catapult on to a tub of water so that they bounced over a taut string to strike a table. Satisfied that the principle was sound, he moved on to Silvermere Lake nearby, where from a larger catapult he projected spherical and oblong shapes over the water, either unspun, forward spun or backward spun. “Golf balls (spheres),” he wrote, “were less satisfactory for ricocheting, but more suitable for aerial bombing and had better ‘ballistic properties’.”



SIR HENRY TIZARD (1885–1959)

Henry Thomas Tizard, an Oxford-educated chemist, served in the Royal Flying Corps during the First World War. During the inter-war years, he became permanent secretary to the Department of Scientific and Industrial Research and chaired the Aeronautical Research Committee, which sponsored

development of Radio-Direction Finding (RDF, later known as Radar). During the Second World War, Tizard advised government departments on aeronautical matters. Following the publication of Barnes Wallis’s “Note”, in April 1941 Tizard convened “a special meeting” of experts “to consider the soundness of the suggestions made by Mr Wallis”, and its favourable conclusions paved the way for formation of the formal Air Attack on Dams. Despite the Air Staff’s rejection of a big bomber for one bomb, Tizard still supported “the ten-ton penetrating bomb”. After Wallis wrote his paper “Spherical Bomb – Surface Torpedo”, Tizard visited him, once more expressed his support, observed tests at the National Physical Laboratory, Teddington, and coined the term “bouncing bomb”. In September 1942, he urged further tests to establish whether the full-size weapon could be carried in a Stirling or Lancaster bomber. After the operation, he informed Wallis: “I have no hesitation in saying that yours is the finest individual technical achievement of the war.” Wallis found him “kindly and very knowledgeable” and remained immensely grateful for Tizard’s support.



THE NANT-Y-GRO MODEL

Towards the close of 1940, while tests were taking place on 1/50th scale models of the Möhne Dam at Harmondsworth and Garston, the search began for a suitable dam on which to experiment with scaled charges intermediate between the models and the target dam. Close to Rhayader in Wales, the disused Nant-y-Gro dam (35 feet (10.7 metres) high, 180 feet (54.8 metres) long was located, and negotiations conducted with the Birmingham Water Company, involving financial compensation for damage inflicted upon it.

No tests on the dam, roughly one fifth the size of the Möhne, took place in 1941, but 1/10th models of it in layered concrete (so that results could be compared with those from the 1/50th scale models of the Möhne)

were built at Harmondsworth. Collins exploded small charges at a distance with no discernible effect.

Then, in February 1942, he detonated a charge against a Nant-y-Gro model with dramatic success. However, work still went ahead in connection with the 10-ton bomb, and on 1 May 1942 the first attempt to breach the Welsh dam by exploding charges at a distance from it failed. A second test on 24 July, during which a charge exploded in contact with the face, shattered the dam wall. Without A.R. Collins's unscheduled contact explosion on the model at Harmondsworth five months earlier, this further test would not have taken place. Wallis could now concentrate on designing a weapon to detonate in contact with the Möhne – the "bouncing bomb".

Furthermore, he decided to back-spin his weapon, which proved a critical decision.

He now composed a paper, "Spherical Bomb – Surface Torpedo", outlining his new proposal without revealing the spin. The weapon would not suffer "initial disturbance by the under-body turbulence of the carrying aircraft at the moment of release, and thus its flight path should in fact be more accurate than that of the ordinary bomb." Moreover, "a sphere would be ideal ... for underwater bombing, where rapid deceleration and good water stabilising are required." The attacking aircraft must "attain a high velocity close to the surface ... By approaching the target in a fast glide and flattening out, the bomb should be dropped from a height not greater than 26 feet when travelling at a speed of 470ft/sec." This type of attack was "particularly suitable" against a hydroelectric dam or reservoir. He foresaw release of the weapon at 3,500 feet

(1,100 metres) roughly two-thirds of a mile/a kilometre from the target.

Wallis went on to explain that "the charge should sink in close proximity (to the target) and may be detonated by a hydro-static valve at any pre-determined depth, the rate of sinking being comparatively slow". He concluded: "This method of attack, permitting the aircraft to turn away at a distance upstream where short-range defences are unlikely to be situated, offers a promising means of obtaining the necessary proximity without undue risk to the aircraft and crew."

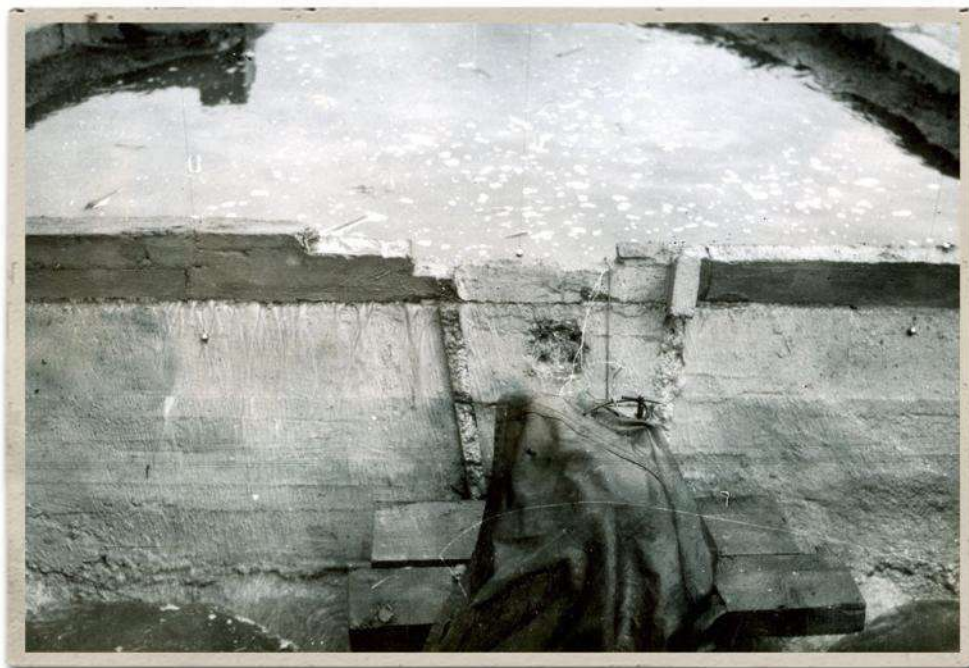
There were strong echoes of Finch Noyes and pre-war data, which Wallis freely admitted he had consulted, but the concept of the weapon and its performance over the water was original, and so was back-spin; the decisive element. Thus, in April 1942, what Sir Henry Tizard would christen the "bouncing bomb" was born.

Opposite-top: A 1/5th scale model of the Nant-y-Gro dam at the Road Research Laboratory, Harmondsworth. Water would have filled the space behind the wall to simulate a reservoir before tests

Opposite-bottom: The Road Research Laboratory at Harmondsworth, alongside the A4 road opposite the current site of Heathrow airport. Model tests were conducted in the field beyond the buildings

Bottom: A contact explosion at the Nant-y-Gro dam model. The images show (small top) the placing of scaled down charge; (main) the model before detonation; and (small bottom) the shattered wall and emptied reservoir after detonation

Below: Arthur Richard "Dick" Collins MBE DSc, a junior scientific officer in the Concrete Section at Road Research Laboratory in charge of tests on dam models 1940–43. He was President of the Institution of Structural Engineers 1968–69



DEVELOPMENT 1942

With the idea of a bouncing bomb now the dominant hope for breaching the dams, it was now time to make the dream a reality

Wallis's new idea immediately impressed the distinguished and influential scientist Sir Henry Tizard. On 23 April 1942, he visited Wallis at Burhill Golf Club, to which the Vickers drawing-office staff had moved to be away from air raids at Weybridge.

Afterwards, Tizard persuaded the MAP to secure use of an indoor tank at the National Physical Laboratory (NPL) for further tests. Apart from one day when the William Froude tank was used, at irregular intervals (as tests on other projects permitted) Wallis's team operated in the No 2 tank – 640 feet (195 metres) long, 23 feet (seven metres) wide and nine feet (2.7 metres) deep, reducing to two feet (0.6 metres) over the final 200 feet (60 metres) – on 23 occasions between 9 June and 22 September 1942. An observer noted that Wallis “rolled up his sleeves and joined in.”

Two-inch (five-centimetre) diameter spheres, in various materials such as lead and balsa

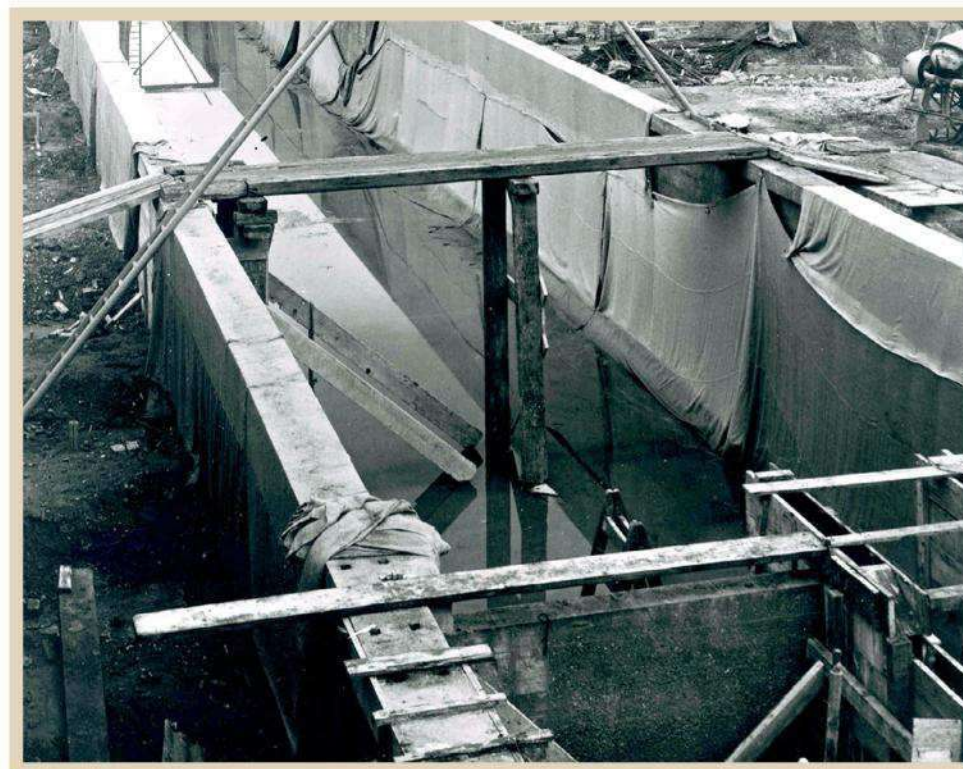
wood were discharged down the tank from a catapult mounted on a raised platform. Timing the bounces helped to determine their consistency, while the principle of ricochet modified their overall performance to aid determination of the weight of the proposed weapon and, particularly, the effectiveness of back-spin. During the tests, Vickers-Armstrong patented the technique, explaining that “the reverse spinning motion applied to the missile has three advantageous effects. (a) It increases the distance which the missile will travel after release from the carrier, before striking the water. (b) It diminishes the tendency of the missile to plunge downwards on impact with the water surface. (c) It increases the distance which the missile will travel while ricocheting.” To establish how a back-spinning weapon would behave once it struck the target, a sheet of metal was lowered into the water towards the end of the tank. Two galvanised cisterns loaded with ballast, open at the top and with a window in the side,

were lowered into the water and balanced on scaffolding on each side of the tank. In one were illuminating lights, in the other a photographer visually recording the action.

On 12 June, Tizard declared results “very promising ... I certainly think now that a full-scale test is desirable with a Wellington.” Dr Pye, chairman of the AAD Committee, was among RAF officers and other scientists to visit Teddington to watch “metal balls bouncing across the water”. Curiously in view of its final form, after the first four tests, Wallis wrote “that a cylindrical form might be more effective than the spherical.” But for the next 10 months, the spherical version dominated his thinking.

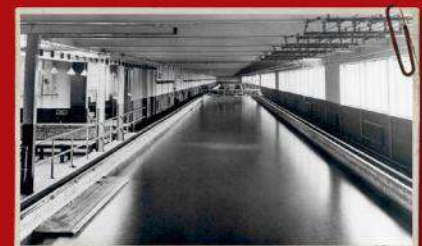
In the midst of the Teddington tests, a crucial one occurred in Wales on 24 July. Had it failed, the Dambusters Raid might never have happened. A 500lb (225kg) anti-submarine mine, containing 279lbs (127kg) of explosive (the approximate scaled-up amount from the charges currently in use), was suspended

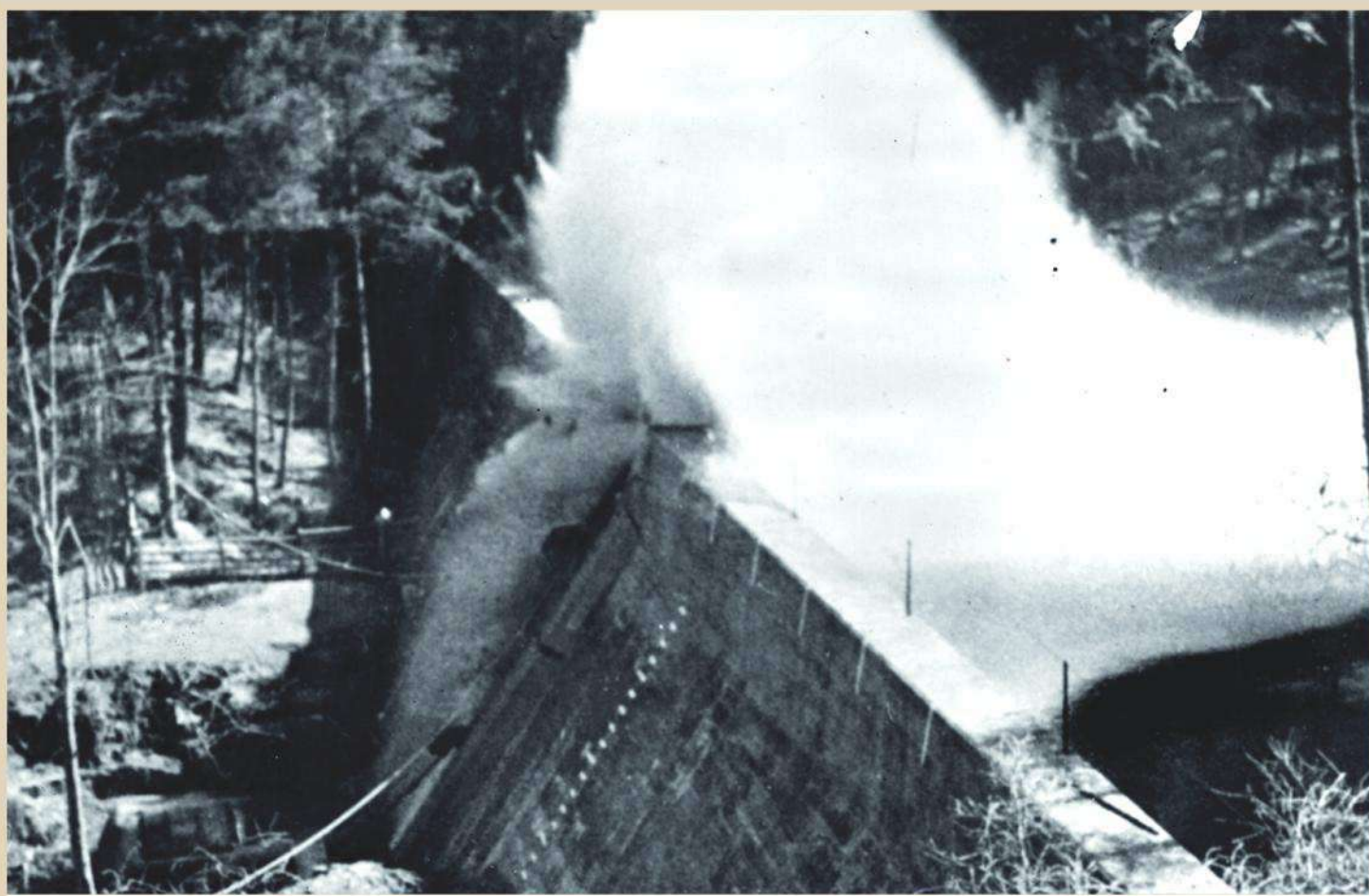
“WALLIS STILL HAD TO DEVISE THE WEAPON TO ACHIEVE THE REQUIRED DEGREE OF ACCURACY. THIS WAS THE END UPON WHICH THE TEDDINGTON TANK TESTS NOW CONCENTRATED”



NATIONAL PHYSICAL LABORATORY

In June 1942, Barnes Wallis and his team began tests at large indoor water tanks in the National Physical Laboratory, Teddington. With the exception of one day (when the Alfred Yarrow tank was used), their work was carried out on No 2 tank. Vickers staff timed the bounces in Wallis's quest for “the elusive” Law of Ricochet. Sir Henry Tizard was among a number of scientists and senior officers to visit Teddington and express their approval. This series of tests ceased on 22 September 1942, but on 30 January 1943 Wallis returned briefly for more testing connected with the effect on the proposed weapon of its impact with a target.





on scaffolding 7.5 feet (2.3 metres) from the crest of the dam and in contact with it. When exploded, a white flash disturbed the surface of the water before erupting into a huge spout. As that subsided, a large hole could be seen in the centre of the Nant-y-Gro Dam. Collins, in his August report, assessed that 1,600kg (7,500lbs) of explosives detonated 30 feet (nine metres) below the surface of water would make a 50-feet (15-metre) deep breach in a gravity dam and, for example, allow 70 per cent

of the water in the Möhne reservoir to escape. This amount of explosive, so much less than that needed for detonation at a distance from a dam, was within the carrying capacity of a Lancaster bomber.

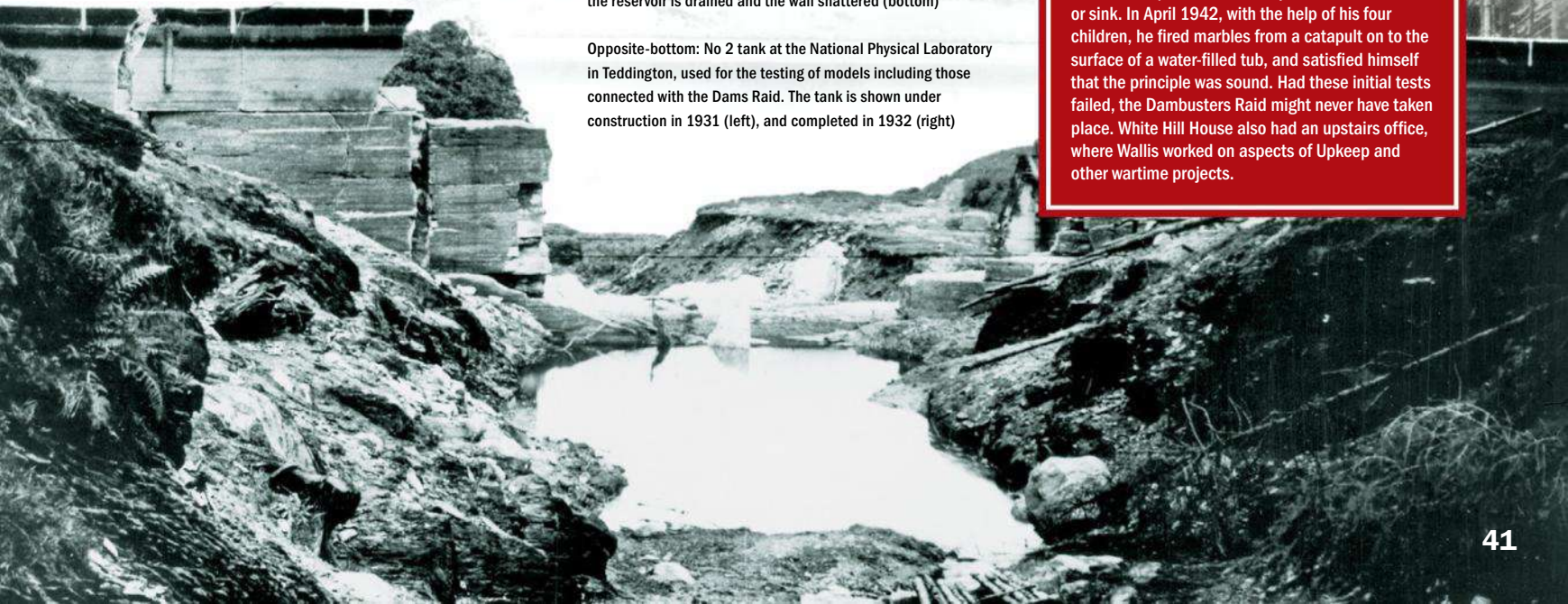
That a contact explosion would succeed was now clear. But Wallis still had to devise the weapon to achieve the required degree of accuracy. This was the end upon which the Teddington tank tests now concentrated.

Above and below: A successful contact explosion at Nant-y-Gro Dam on 24 July 1942. The wall begins to crumble (top); afterwards the reservoir is drained and the wall shattered (bottom)

Opposite-bottom: No 2 tank at the National Physical Laboratory in Teddington, used for the testing of models including those connected with the Dams Raid. The tank is shown under construction in 1931 (left), and completed in 1932 (right)

WHITE HILL HOUSE

On the rear patio of his home, White Hill House in Effingham, Barnes Wallis began experiments, which would culminate in Upkeep, the "bouncing bomb". Following demonstration by the Road Research Laboratory scientist A.R. Collins that a charge exploded against a dam wall would breach it, Wallis explained: "I had the idea of a missile, which ... would reach the dam in a series of ricochets". He envisaged a spherical weapon and needed to establish consistency of performance ("The Law of Ricochet") and whether a sphere would bounce or sink. In April 1942, with the help of his four children, he fired marbles from a catapult on to the surface of a water-filled tub, and satisfied himself that the principle was sound. Had these initial tests failed, the Dambusters Raid might never have taken place. White Hill House also had an upstairs office, where Wallis worked on aspects of Upkeep and other wartime projects.



SECRET AND PERSONAL

54, Broadway,

S.W.1.

14th September, 1942.

Insert on pp. 138
Whole of pages 2 & 3.



Dear

I attach the notes I promised concerning
B.N. Wallis and his invention.

only this
from this
page

In my whole experience of aeronautical engineers
and inventors, I have never come across one whom I
consider more able, and it seems a pity that such a
man (whose brain is probably worth four or five thousand
a year) should be baulked so consistently by a Civil
Service mind, whose maximum value is probably six hundred
per annum.

Excuse me for speaking rather plainly.

Yours sincerely,

G.M. Garro Jones, Esq.,
Parliamentary Secretary,
Ministry of Production,
Great George Street,
S.W.1.

ITEM 05

**A LETTER FROM GROUP CAPTAIN
F.W. WINTERBOTHAM TO G.
GARRO JONES, PARLIAMENTARY
SECRETARY TO THE MINISTER OF
PRODUCTION,
14 SEPTEMBER 1942**

Group Captain F.W. Winterbotham, Head of the Air Section of MI6, was so impressed by Barnes Wallis's scheme for his 10-ton bomb that in mid-1940 he decided that he "must summon the Air Staff ... without delay" to support it and later ensured that Winston Churchill's scientific adviser, Professor F.A. Lindemann, received a copy of A Note. When Wallis approached him with his new idea of the bouncing bomb, Winterbotham hoped this time it would be "a properly baked pie - not under-cooked blackberries". The letter to Garro Jones stemmed from frustration at the lack of progress made after the successful Nant-y-Gro contact explosion in July 1942. Winterbotham included a page of notes outlining the project so far (included here).

To Sam Jones

2

Notes on the Work of Mr. B.N. Wallis

Airframe designer to Vickers Aviation.
Inventor of Geodetic Construction.
Designer of the Wellesley and the Wellington.

In March 1941, he put forward comprehensive proposals for the construction of a Stratosphere Bomber to carry 10 ton bomb, for destruction of Axis primary sources of power - coalmines, water power dams and oil refinery and storage plants - by utilisation of new and hitherto unrealised potentiality of 'shock wave' of large bombs.

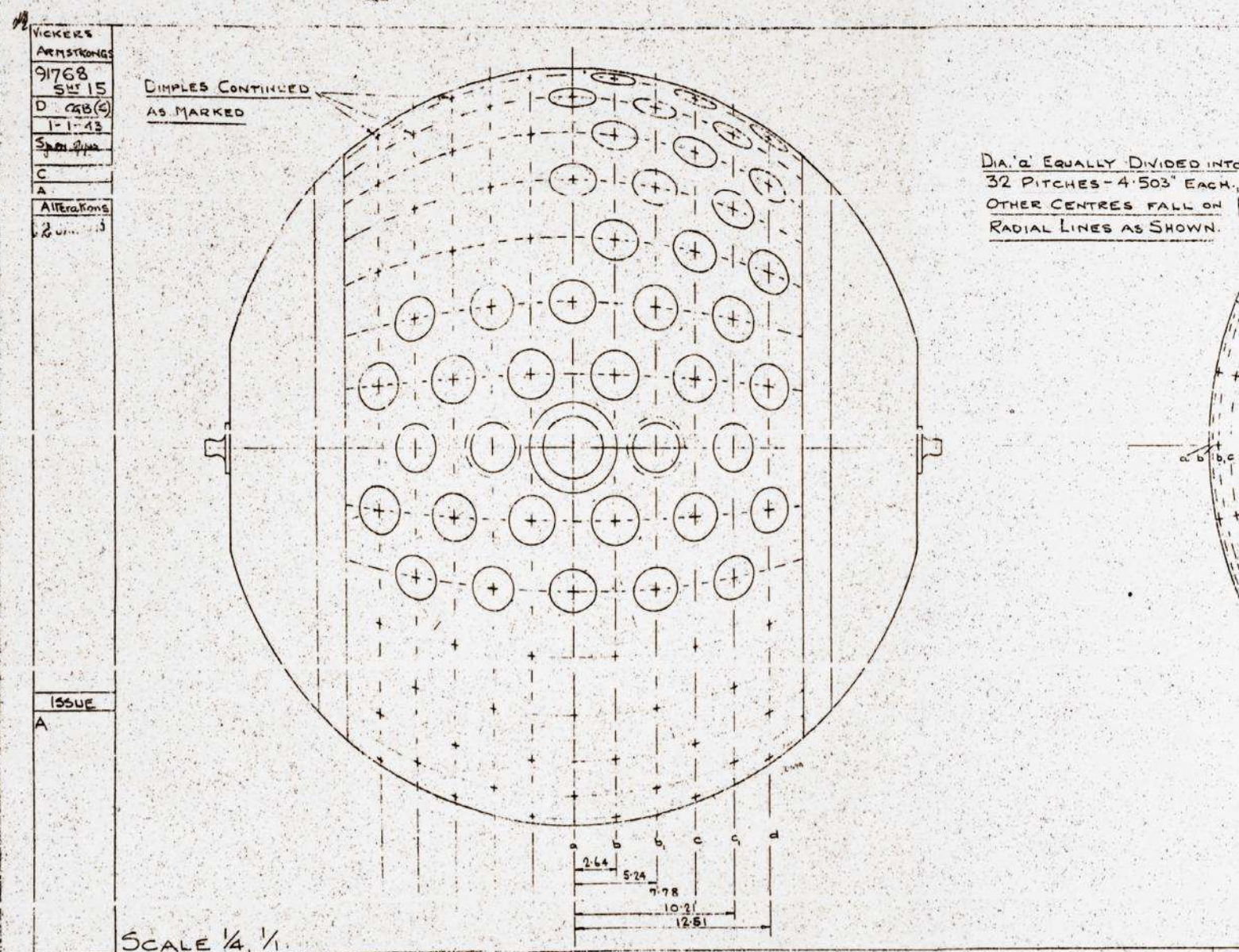
The proposition was favourably viewed by Lord Beaverbrook, and its possibilities were admitted by a technical committee set up by Sir Henry Tizard to report on Wallis's paper. It was, however, turned down by the Air Staff, but in spite of this resulted in the formation of an "Air Attacks on Dams" Committee under the chairmanship of Dr. Pye (Director of Scientific Research of the Ministry of Air Production).

During 1941 - 1942, Wallis has continued to press forward with methods of destroying enemy water dams. It is considered that the question of the amount of damage which could be caused by the destruction of enemy water power has not been fully realised, for instance, the destruction of the Möhne dam at the head of the Ruhr Valley would flood the valley, and put many factories out of action, thus saving much costly bombing: whilst the destruction of the hydro-electric power in Italy would cripple transport and industry throughout that country.

Experiments have shown that the destruction of large dams requires bombs at least of the size forecast by Wallis, and even larger, when they are dropped in the usual way and explode in the water as "near misses". This is presumably the reason why the project has not been favourably received by the Air Staff, but experiments have also shown that large dams can be destroyed by much smaller charges than those required above, provided that the charge is detonated in actual contact with the masonry of the dam on the water side at a considerable depth below the surface.

It is agreed that it is impossible to accomplish the second method by ordinary bombing, and Wallis has accordingly invented a "surface torpedo" which when dropped by a low-flying aircraft will travel a considerable distance (estimated at about one mile) along the surface of the water.

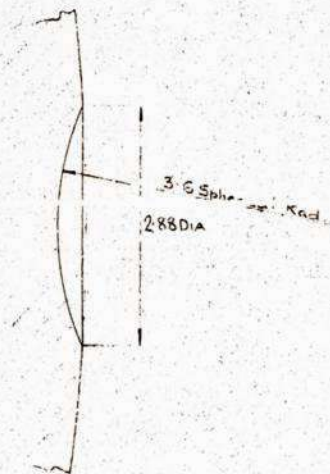
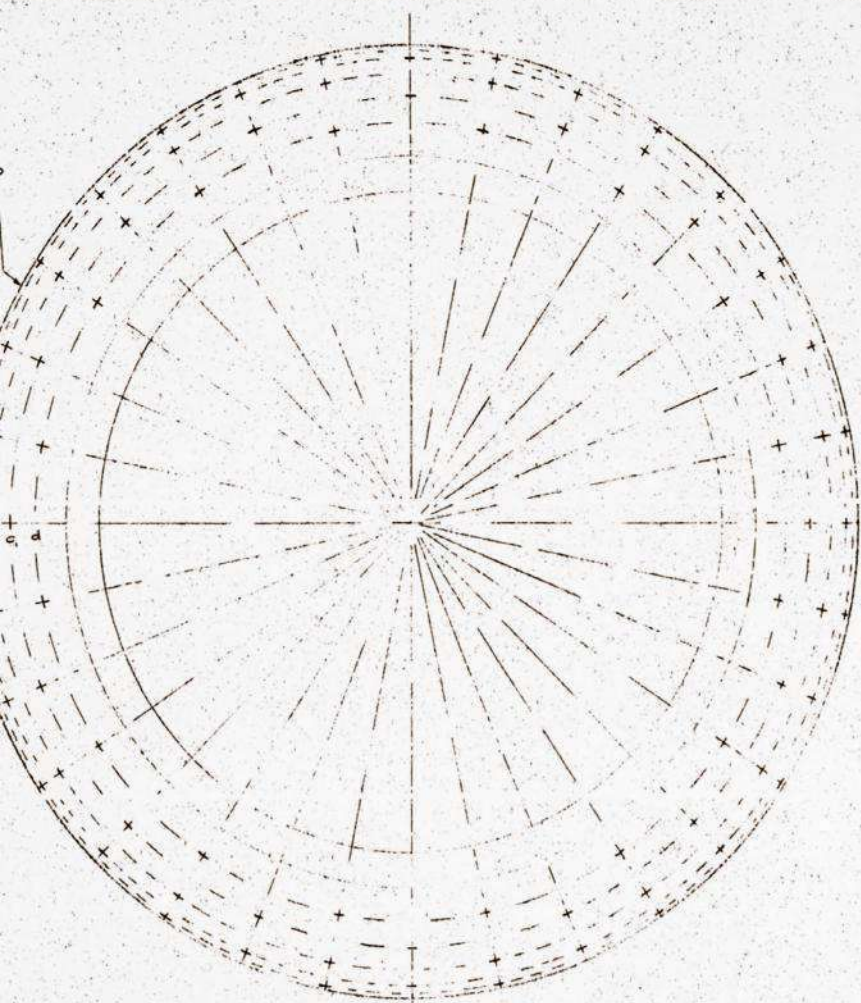
The/



ITEM 06

TECHNICAL DRAWINGS FOR A TRIAL VERSION OF THE "BOUNCING BOMB"

Towards the end of 1942, Barnes Wallis envisaged the final version of his "bouncing bomb" destined for the dams being 7 feet 6 inches (2.3 metres) in diameter. Tests had so far involved 2-inch (5-centimetre) balls fired over the water, so trials with a 4 feet 6 inch (1.4 metre) version released from a Wellington to obtain intermediate data took place at Chesil Beach during the winter 1942-23. Welded metal spheres with flattened ends or similar wooden ones, either smooth or dimpled, were used. These are diagrams of a wooden sphere. On 24 January, one bounced "20-22" times; on 5 February another travelled 1,315 yards (1.2 kilometres).

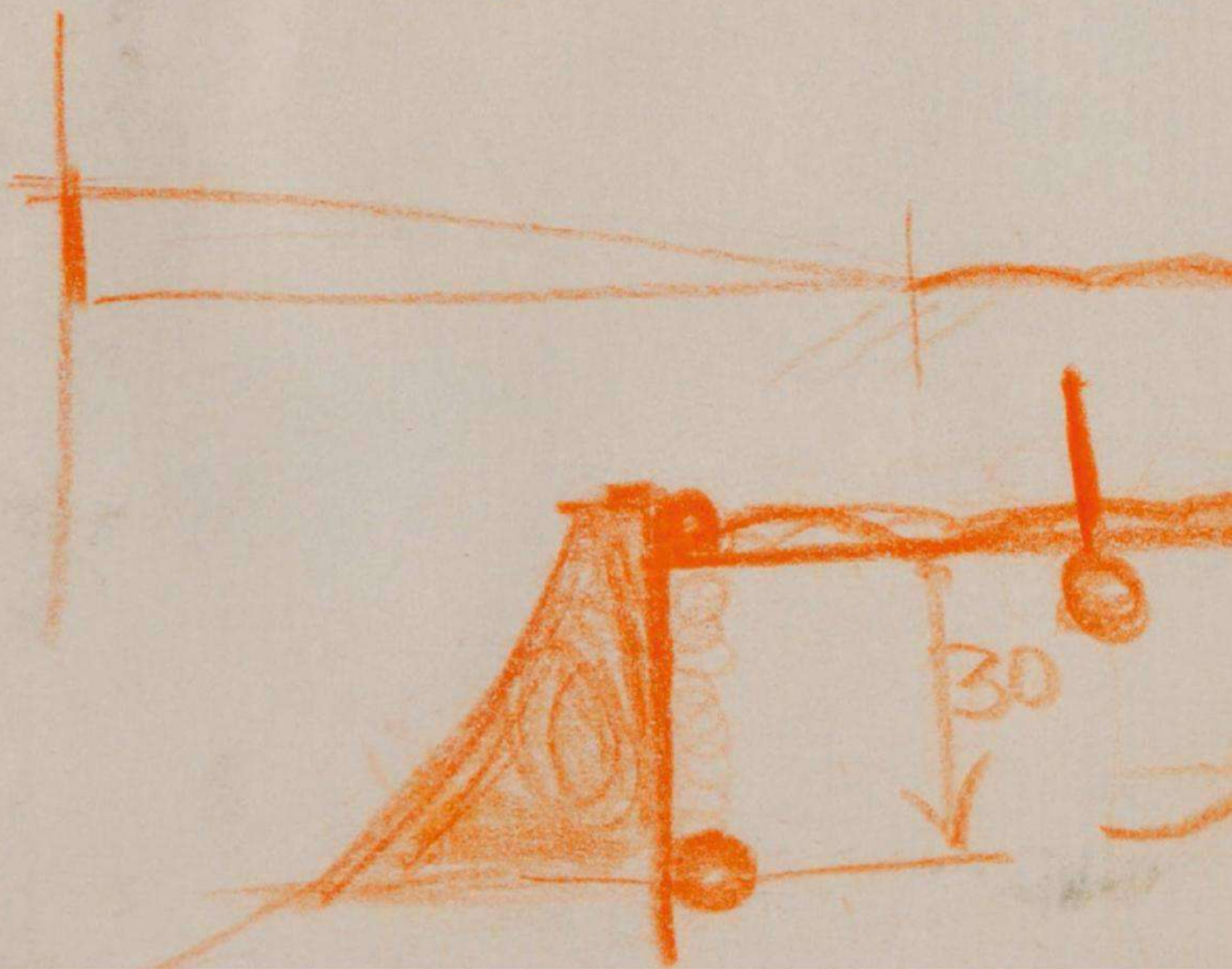
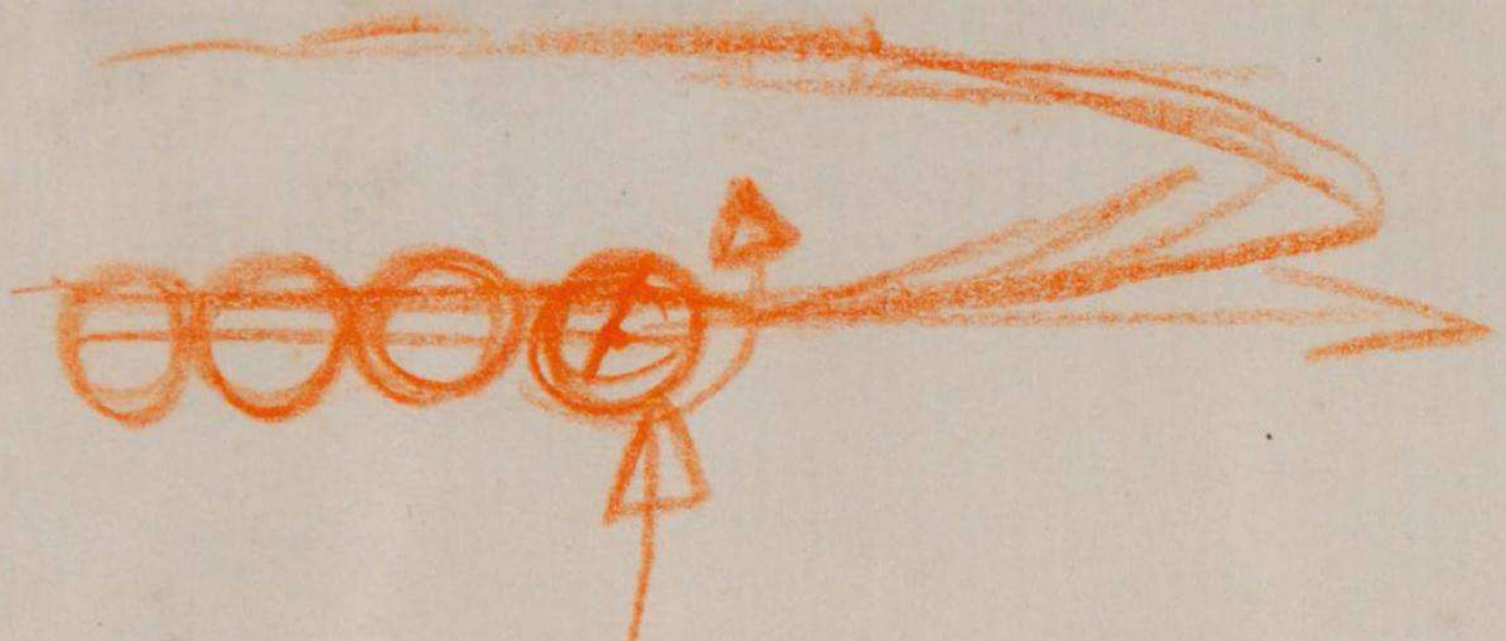


SECTION OF DIMPLE.

No Off Per %	DIMPLING		
—	WOODEN SPHERE	SHT 15	91762
—		VICKERS ARMSTRONGS	

CIT

**“WELDED METAL SPHERES WITH FLATTENED ENDS OR SIMILAR
WOODEN ONES, EITHER SMOOTH OR DIMPLED, WERE USED. THESE
ARE DIAGRAMS OF A WOODEN SPHERE”**





ITEM 07

BARNES WALLIS'S ROUGH SKETCH OF UPKEEP

To gain support for use of his bouncing bomb, Barnes Wallis approached individual RAF staff officers. These are explanatory sketches for Captain C.E.H. Verity. The image top left shows Upkeep in position before being released, the image top right shows it being back-spun. Below is the weapon in its planned shape and an illustration of how the flattened sphere would bounce towards the Möhne Dam, crawl down its face and explode 30 feet (9 metres) below the surface of the water.

Note how the height of the bounce decreases as the bomb approaches the Dam.

SCIENTIFIC DOUBTS

1940–1943

Wallis was confident with his design, but not everyone was convinced...

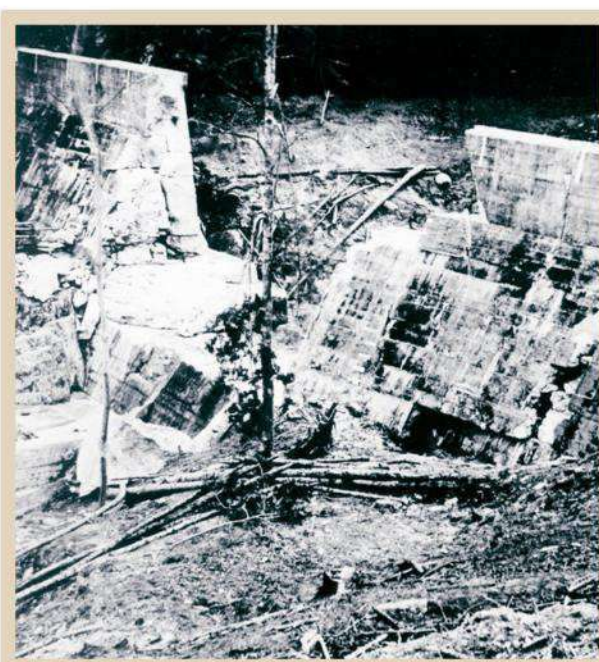
The successful mid-1942 test results encouraged the RAF to allocate a Wellington bomber for more exploratory trials. Wallis was planning a weapon measuring about 7ft 6ins (2.3 metres) in diameter, so a 4ft 6in- (1.4-metre) sphere installed in a Wellington would provide intermediate calculations beyond those obtained with two-inch (five-cm) spheres.

Before any such trials could take place (planned at Weybridge under Vickers-Armstrong's control), scientific doubts about the practicality of Wallis's proposals arose. Professor E.N. da C. Andrade (a member of the AAD Committee) had challenged the scientific basis for Wallis's 10-ton proposal, and similar reservations surfaced concerning the bouncing bomb. Even before the Teddington tests were completed, Dr Pye wrote dismissively: "I think we can safely say that the gravity dam is a hopeless proposition." On 29 September, Wallis recorded: "I see Lord Cherwell and find him very unresponsive."

Against this background of scepticism, on 20 October 1942 the first spinning tests took place on the ground at Weybridge. Then, on 2 December, as Captain "Mutt" Summers flew over a reservoir near Staines, Wallis used the hydraulic system which normally operated the bomb-bay doors to spin four scaled-down spheres and convinced himself that no gyroscopic effect would stem from rotating the proposed weapon aloft. The scene now moved to a strip of water in Dorset between Chesil

Beach and the mainland, where scaled versions of the weapon were dropped from a Wellington at intervals between 4 December 1942 and 9 March 1943.

Meanwhile, Wallis had completed another paper, "Air Attack on Dams", describing "the effect of destroying the large barrage dams in the Ruhr Valley, together with some account of the means of doing it." The 19 pages of text, backed by tables and footnotes, diagrams and illustrations, maintained that 6,500lbs (2,950kg) of explosive (not Collins' 7,500lbs/3,400kg), if exploded in contact with its face 30 feet (nine metres) below the water level, would breach "the largest gravity dams in Germany", and listed the seven dams identified in the 1939 Air Staff document. Despite its different construction, he was also confident that the central core of the Sorpe could be cracked. The five Ruhr dams held back a total of 332 million cubic yards (254 million cubic metres) of water, and draining the Möhne reservoir alone would "cause a disaster of the first magnitude ... in the lower reaches of the Ruhr". The two Weser valley dams restrained 290 million cubic yards (222 million cubic metres) of water, used principally to supply the Mittelland canal, crucial for the transportation of industrial



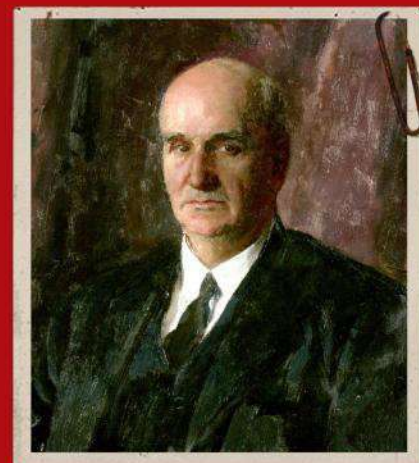
products and important hydroelectric power stations. Wallis explained how his "spherical torpedo" would ricochet over a reservoir, sink beside a dam wall and decisively detonate.

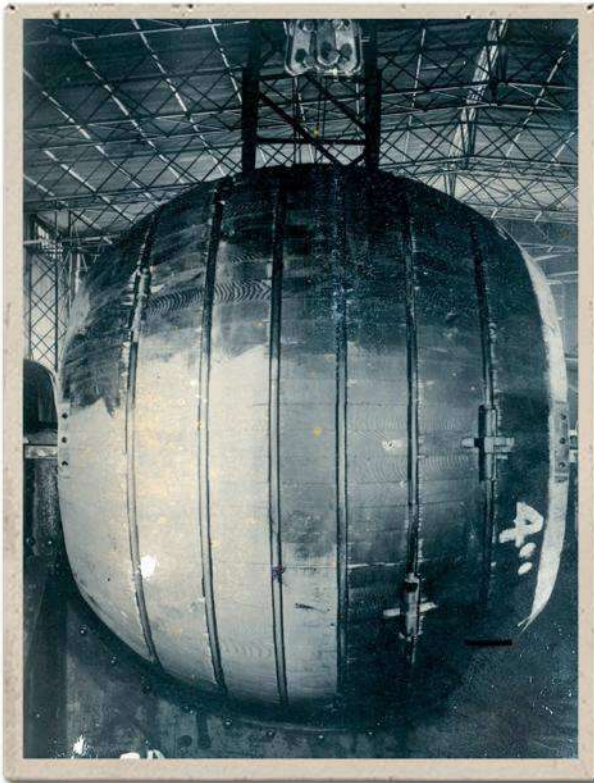
On receiving his copy, Cherwell showed less antagonism in another meeting with Wallis, and Benjamin Lockspeiser at the MAP displayed positive support. It would soon emerge that RAF officers were rather less enthusiastic.

LORD CHERWELL (1886–1957)

Frederick Alexander Lindemann (Lord Cherwell) was a distinguished physicist and Professor of Experimental Philosophy at Oxford with a formidable personality. During the First World War, he did invaluable work at the Royal Aircraft Factory in Farnborough to counteract spin in aircraft. In the inter-war years, he retained a special interest in the air, being involved with Sir Henry Tizard's investigation into the potential of Radio-Direction Finding (radar). In 1940, Winston Churchill appointed "The Prof" as his scientific adviser, and two years later made him Paymaster-General in the government. Created Baron Cherwell in 1941, in the same year Lindemann dismissed Wallis' 10-ton bomb proposal as impossible to achieve before the end of the war. Even after the second

test on the Nant-y-Gro dam had proved that a contact charge would breach a dam, on 19 September 1942 Wallis recorded: "I see Lord Cherwell and find him very unresponsive ... (he) doubted if the Dams were of any consequence." But, at another meeting on 2 February 1943 following receipt of Wallis' "Air Attack on Dams" paper, Cherwell was less hostile. A fortnight later, he reacted positively to photographs of the Teddington tests and contacted the Ministry of Aircraft Production. Although Cherwell belatedly expressed support for the "bouncing bomb" concept, he did so at a time when events were moving rapidly towards approval for Operation Chastise. Given his influence, though, a negative response could still have been decisive.

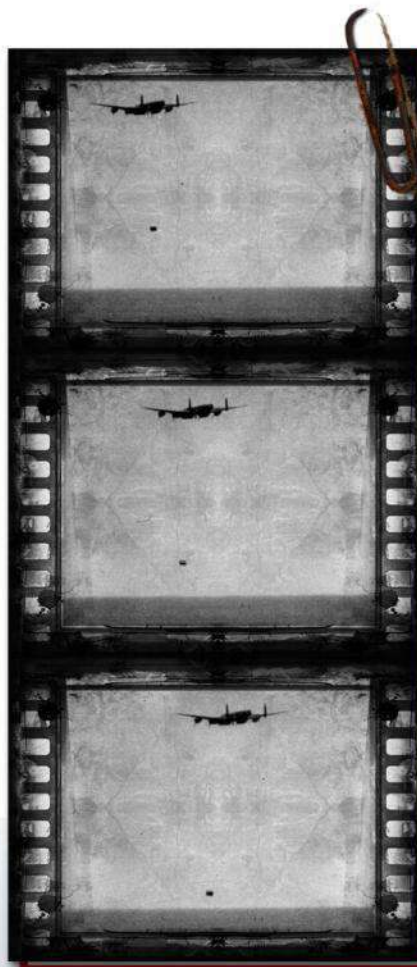




Opposite: After the positive contact detonation in February 1943, further tests were carried out on models of the Nant-y-Gro dam in preparation for the live test on the dam itself in July

Above-left: A scaled-down practice version of a bouncing bomb showing the wooden exterior held in place by metal bands and the flattened ends of the sphere

Below: A Vickers Wellington. One of these machines (BJ895/G) carried out the practice drops at Chesil Beach between December 1942 and March 1943, and the first at Reculver on 13 April 1943



CHESIL BEACH TRIALS

On 4 December 1942, Vickers' test pilot Captain J. "Mutt" Summers flew Wellington BJ895/G, a modified machine with the bomb-bay doors removed and apparatus installed to hold, spin and release a half-scale 4ft 6ins (11-cm) diameter spherical bomb, to the Chesil Beach bombing range in Dorset for dropping trials. With a camera on the ground recording the east-to-west flight, two welded spheres were dropped and burst on impact. Reinforced with granulated cork and cement, two more spheres (one dimpled, one smooth) were released on 15 December from 60 feet (18 metres) after Summers had dived at top speed. This time, and for all subsequent trials, a camera was carried on board to supplement the ground one. One sphere was found to be damaged, but not broken. On 9 January 1943, the third trial took place with two spheres unsuccessfully dropped, but another the following day "did one enormous bounce to a ht (sic) of 55 feet." During the fourth trial on 23 January, a sphere dropped from 42 feet (12.8 metres) and revolving at 485 revolutions per minute (rpm) bounced 13 times, and one dropped two days later "20-22" times. On 5 February, another sphere ran 1,315 yards (1,200 metres). The final drops at Chesil Beach were conducted 8-9 March 1943. Without these trials in the winter of 1942-43, approval for the full-size Upkeep could not have been secured.

"AGAINST A BACKGROUND OF SCEPTICISM, ON 20 OCTOBER 1942 THE FIRST SPINNING TESTS TOOK PLACE"



SERVICE OPPOSITION 1943

The RAF were less enthusiastic about Wallis's creation

On 3 February 1943, the day after he secured Lord Cherwell's approval, Wallis learnt that the RAF would only agree to "preliminary design work". Nine days later, a lukewarm appreciation reached the Air Staff: "Model experiments, mathematical analysis and full-scale drops of a smaller weapon, all indicate that the Upkeep

[the codename for the bouncing bomb] project is technically feasible"; this was well short of unqualified approval.

On 13 February an Air Ministry meeting, not attended by Wallis, considered "the development and possible operational use of the spherical bomb." It learnt, slightly erroneously, that Upkeep would include a 7,500lb (3,400kg) charge, weigh 11,000lbs (5,000kg) and be 84 inches (2.1 metres) in diameter. Success at Chesil Beach was acknowledged, but the meeting felt there was no proof that the weapon would be in a fit state to function after it hit the target. Furthermore, "considerable modification" would be required to a Lancaster, and no attack on the dams could be foreseen for six months.

The following day, Air Vice-Marshal R.H.M.S. Saundby at Bomber Command produced a lengthy minute for his chief, Air Marshal Sir Arthur Harris, to which he attached a copy of "Air Attack on Dams". Some details differed slightly from those presented to the Air Ministry meeting: the weapon "for the special purpose of destroying dams, the Möhne in particular" would weigh 10,000lbs (4,500kg), contain a "6,500lb" charge and be "about" seven feet (two metres) in diameter. After sketching the form and purpose of Upkeep, Saundby revealed that an attack must be launched when a reservoir was full "or nearly full"; and a Lancaster squadron should be withdrawn from normal duties for "two or three weeks".

Harris reacted swiftly: "This is tripe of the wildest description. There are so many ifs & buts that there is not the smallest chance of its working ... I don't believe a word of its supposed ballistics on the surface ... The war will be over before it works - & it never will."

On 18 February, he returned to the attack, addressing a personal letter to the CAS, Air Chief Marshal Sir Charles Portal: "All sorts of enthusiasts and panacea mongers [are] career[ing] around MAP suggesting the

taking of 30 Lancasters off the line to rig them up for this weapon." He continued: "The job of rotating some 1,200 lbs (sic) of material at 500rpm on an aircraft is in itself fraught with difficulty ... I am prepared to bet my shirt (a) that the weapon itself cannot be passed as a prototype for trial inside six months; (b) that its ballistics will in no way resemble those claimed for it; (c) that it will be impossible to keep such a weapon in adequate balance either when rotating it prior to release or at all in storage; and (d) that it will not work, when we have got it." Finally, Harris pointed out that attempts to carry out "low attacks with heavy bombers" had been "costly failures".

On 22 February, visiting Harris at Bomber Command headquarters, Wallis received a disparaging greeting: "My boys' lives are too precious to be thrown away by you." Even

AIR CHIEF MARSHAL SIR ARTHUR HARRIS (1892-1984)

Arthur Travers Harris spent his youth in Africa and served in the 1st Rhodesian Regiment during the First World War before joining the Royal Flying Corps in England in 1915. He saw active service on the Western Front, secured a permanent commission in the RAF and during the inter-war years was involved in imperial policing on the North-West Frontier of India and in Mesopotamia. By the time that he became a member of the Chiefs of Staff Joint Planning Committee (1934-37) he was committed to bombing and backed development of four-engine bombers. In 1938, as an air commodore, he led an aircraft-purchasing commission to the USA.

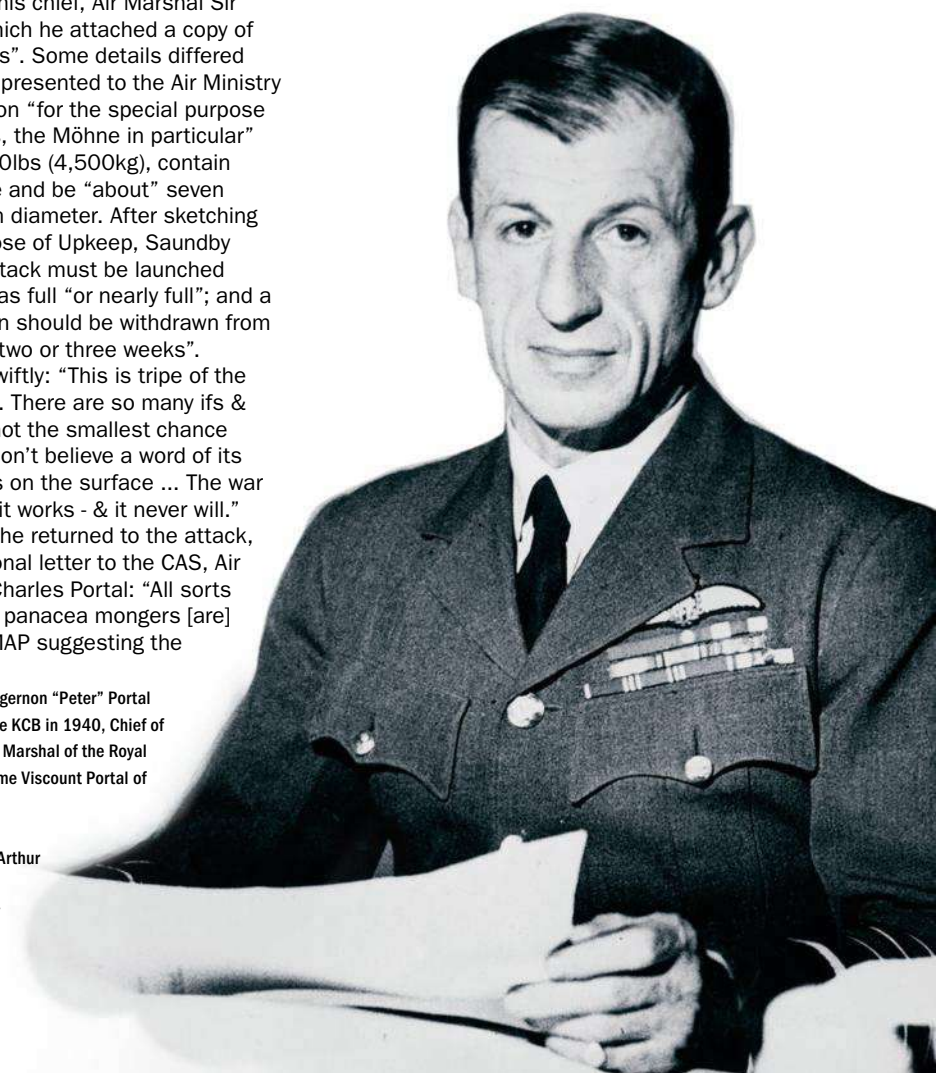
On the eve of the Second World War, as an air vice-marshal he was Air Officer Commanding (AOC) Palestine and Transjordan. Back in England, he led 5 Group, equipped with Handley Page Hampdens, in the early months of the war, before moving to the Air Ministry as Deputy Chief of the Air Staff. After another mission to the USA, Harris became AOC-in-C Bomber Command in February 1942 as an air marshal. It was his job was to implement the policy of area bombing which had been laid down. Appointed KCB in June 1942, he remained at High Wycombe for the rest of the war, advancing to air chief marshal in 1943.

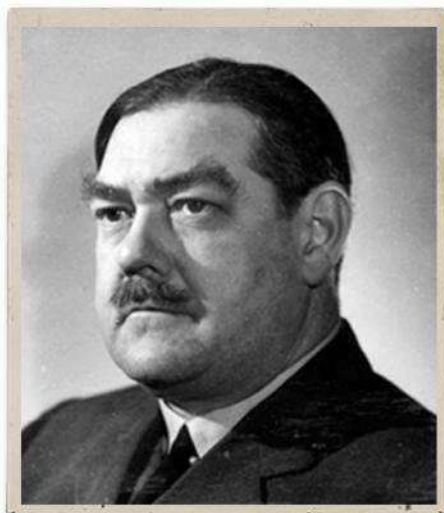
He left Bomber Command in September 1945 and was promoted Marshal of the Royal Air Force on 1 January 1946.



Right: Charles Frederick Algernon "Peter" Portal (1893-1971). He was made KCB in 1940, Chief of the Air Staff 1940-45 and Marshal of the Royal Air Force in 1944. He became Viscount Portal of Hungerford in 1946

Left: Air Chief Marshal Sir Arthur Harris (right) with Air Vice-Marshal R.H.M.S. Saundby (centre) in his Bomber Command office





after seeing a film of the Chesil Beach trials, Harris remained hostile. As Air Vice-Marshal Cochrane observed, Wallis intended to project "a five ton lump of iron across a lake." The very next day, Wallis was summoned to London, where Vickers-Armstrongs chairman Sir Charles Craven told him he was making a perfect nuisance of himself at the MAP, was damaging the company's commercial interests and must

"stop this silly nonsense about the destruction of the dams." Craven reminded Wallis that he was paid by his firm to work on the new Windsor bomber, not Upkeep.

Top-left: Robert Henry Magnus Spencer "Sandy" Saundby (1896–1971), Senior Air Staff Officer and RAF Bomber Command in 1940 and Deputy Air Officer Commanding-in-Chief in 1943. He was made KBE in 1944 and Air Marshal in 1945

Bottom-left: Norman Howard Bottomley (1891–1970) in 1943 chaired committee monitoring progress of the Dams operation. He was made KCB in 1944, and in 1945 succeeded Harris at Bomber Command. In 1948 he retired as Air Chief Marshal

Top-right: Bomber Command headquarters. Air Chief Marshal Sir Arthur Harris studies reconnaissance photos. In the foreground staff analyse data

SIR CHARLES CRAVEN (1884–1944)

Commander Charles Worthington Craven (left) served in the Royal Navy during the First World War before being released to supervise the construction of submarines and naval airships at Vickers in Barrow in 1916. Aged 47, in 1931 he was appointed managing director of Vickers-Armstrong, the vast armaments firm formed four years earlier, and from January 1936 until his death in 1944 he served as company chairman. His energy and business sense steered the company through the recession, to be ready for the rearmament programme. A powerful presence, he "attracted a kind of loyalty in the yards and workshops, which no one else in the history of the company had ever achieved." But he remained "a naval officer to his

fingertips," as Barnes Wallis discovered in February 1943 when Craven told him to cease work on the "bouncing bomb". Wallis demurred and Craven accused him of mutiny. Craven's reasoning was that Wallis had been side-tracked from other commercial commitments. Early in the Second World War, Craven advised the Admiralty, and then, in April 1940, joined the Air Council as Civil Member for Development and Production. On its formation the following month, Craven went to the Ministry of Aircraft Production (MAP), before returning to Vickers-Armstrongs in November 1940. He again advised the MAP in 1941–42 and acted as industrial adviser to the Ministry of Production in 1942–43. He was created a baronet in 1942.



CHANGE OF MIND

FEBRUARY 1943

With a date for the raids set for May, work began on modifying the Lancaster bombers and creating bombs to use

Three days later, Wallis was summoned to another meeting in London, this time at the MAP chaired by Air Vice-Marshal F.J. Linnell (Controller of Research and Development) to receive another shock. The atmosphere was altogether less confrontational, the decision of 23 February swept aside. In stressing need for absolute security, Linnell revealed that the Chief of the Air Staff (Portal, who had sponsored the 1940 attack on the Möhne) wanted “every effort” to mount the dams operation in spring 1943. Three Lancasters were to be modified immediately for Upkeep trials, another 27 similarly altered for use by the operational squadron. 26 May would be the latest date for striking the dams – soon brought forward to 19 May, just 11 weeks away.

The “mines” (a term employed in subsequent documents) and all modified aircraft were to be ready by 1 May “to allow a reasonable period for training and experiments”. Avro would deal with strongpoint attachments to the airframe of the Lancaster, bombcell fairings, bomb-release electrical wiring and the hydraulic powerpoint for the rotating weapon; Vickers-Armstrong would be responsible for Upkeep, the calliper arms to hold it and the mechanism for its rotation. Wallis recorded: “It appears that we are to go ahead at full speed, and my only fear now is that this important decision may have been arrived at too late.”

Not until 28 February had he outlined the full-scale Upkeep drawings and explained that he planned a near-spherical steel weapon with flattened sides. However, shortage of steel determined that the charge must be contained in a smaller steel cylinder, the full size being achieved by packing around it held together by “great staves of wood” contained by six 1 1/2in (3.8cm) diameter steel bands. Three standard naval hydrostatic pistol pots would be fitted with normal horseshoe washers and armed by hand before take-off. In case these failed, a fourth self-destructive device would be fitted and armed “when the store (Upkeep) leaves the aircraft”.

During the next week, arrangements were made for the steel cylinders and wooden exteriors to be made at various Vickers-Armstrong works and sent to Royal Ordnance factories at Chorley and Woolwich for live and inert filling respectively. Roy Chadwick, Avro chief designer, revealed that the modified Type

464 Provisioning Lancaster would be powered by American-built Merlin 28 engines and, to compensate for Upkeep’s weight, would fly with no mid-upper turret. A belt with 195-in (495-cm) inside measurement would be fitted on the starboard side of the aircraft, whose bomb-bay doors had been removed, and be driven by a motor mounted on the floor of the fuselage. Full-scale drawings were finalised and distributed on 4 March. A delay had been caused, because Wallis had only belatedly seen plans of the Lancaster and needed to reduce the length of the charge cylinder according to the Lancaster.

Work at the different locations forged ahead rapidly. By 12 April, the three modified Lancasters allocated for trials were ready, and

the overall total had been reduced from 30 to 23. Production and filling of Upkeeps was progressing well, the fourth self-destructive pistol had been designed by the Ministry of Supply and an Admiralty scientist, in answer to a query from Wallis about the impact of an explosion at the dam on the adjacent reservoir, wrote: “I feel confident that after five minutes the height of the waves will be measured in inches rather than feet.” A charge of 6,600 pounds (3,000kg) of Torpex underwater explosive was determined, and on 7 April static tests at Foxwarren convinced Wallis that, spun at 500rpm, Upkeep would not leap out of the restraining calliper arms. Meanwhile, work to assemble the squadron destined to deliver Upkeep was well underway.

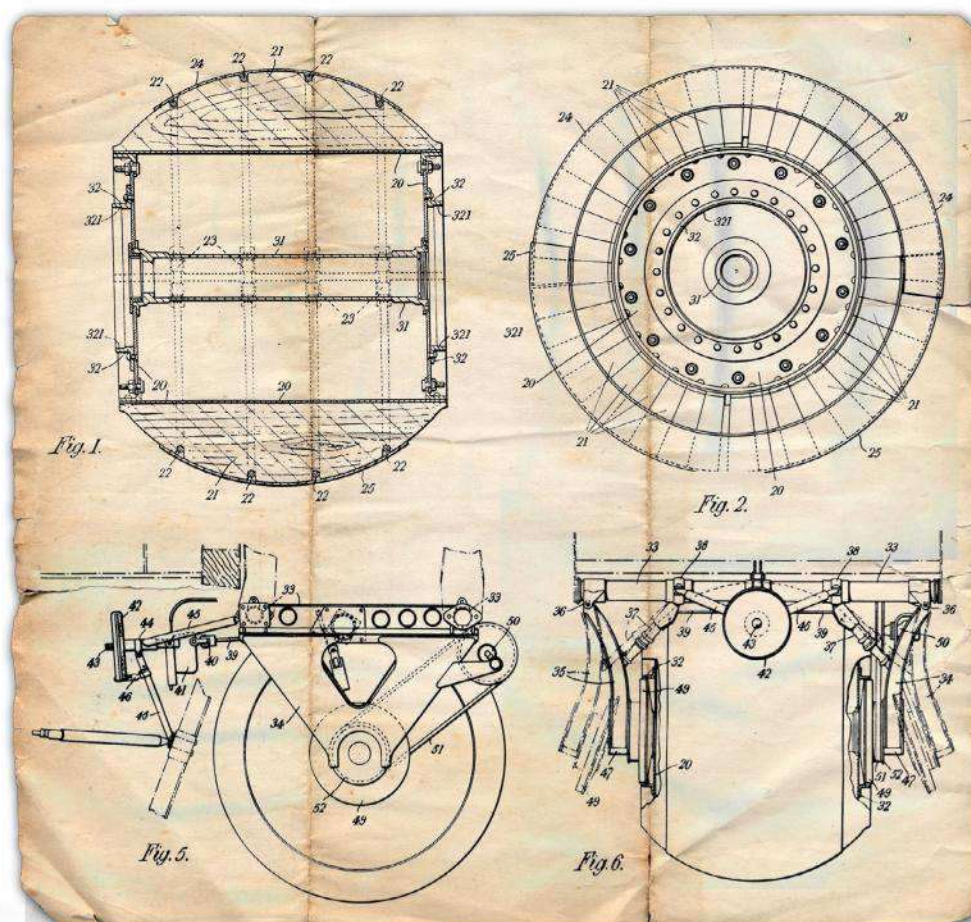
THE MODIFIED LANCASTER

Although use of an Avro Lancaster to carry Barnes Wallis’s “bouncing bomb” was raised in September 1942, it was not seriously considered until February 1943. At that stage, Upkeep was intended to be 11,000lbs (5,000kg) in weight and, with the details of the four-engine bomber unknown to him, Wallis had to reduce its planned length to fit into the bomb-bay. Roy Chadwick, chief designer of A.V. Roe & Co (Avro), realised not only that this bulky weapon could not be carried internally, but that the mid-upper turret would need to be removed effectively to balance it, a proposal rapidly approved by the Air Ministry.

And so the “Type 464 Provisioning” was born, a Lancaster III driven by Merlin 28 engines, built under

license by the Packard Motor Company of Detroit, and which also included modifications specifically connected with Operation Chastise. The bomb-bay doors were removed and the hydraulic power involved diverted to a motor mounted on the starboard side of the fuselage floor to activate the angled belt, which rotated Upkeep. Aldis lamps, to allow judgement of height, were placed in the rear of the bomb-bay and the front camera slot, and calliper arms fitted to protrude beneath the bomb-bay between which Upkeep would be clamped and spun. The first modified Lancaster, destined for trials off Reculver reached RAE Farnborough on 8 April, and the twentieth (and final) one got to RAF Scampton on 13 May.





Top-left: Francis John Linnell (1892–1944), Controller of Research and Development at the Ministry of Aircraft Production 1940–43, was closely involved in Upkeep development. He was made Air Marshal in 1943 and KBE in 1943

Top-right: A scaled-down version of Upkeep being used to test

the release mechanism. Herbert Jeffree (left) is supervising and Sammy Walsh of Vickers-Armstrongs's staff is right

Above: Diagrams showing Upkeep in profile, end section and clamped between the two calliper arms attached to a modified Lancaster's fuselage

“BY 12 APRIL, THREE MODIFIED LANCASTERS ALLOCATED FOR TRIALS WERE READY”

UPKEEP

Barnes Wallis originally envisaged a near-spherical steel weapon 7ft 6ins (229cm) in diameter with flattened poles, so that it could be clamped and spun beneath an aircraft. However, the Ministry of Supply estimated a two-year delay before the necessary steel could be guaranteed. That is why Wallis settled on a smaller, 3/8-inches (95-mm) thick steel cylinder to contain the charge, the full size being achieved by placing packing round it and “great staves of wood” secured by metal bands sunk in grooves to keep that in place. The steel cylinders and exterior wooden casings would be produced at Vickers-Armstrong's factories, the cylinders being sent to Royal Ordnance works at Chorley for live filling, and Woolwich Arsenal for inert filling destined for practice weapons. Cylinders and wooden casings were to be united at a nominated RAF station. The dropping trials at Reculver led to removal of the outer casing in mid-April 1943, so Upkeep ultimately comprised only the charge cylinder. Resembling a garden roller, the “bouncing bomb” which went to the dams was 59 7/8 inches (52cm) long, and 50 inches (127cm) in diameter. It contained 6,600 pounds (3,000kg) of Torpex underwater explosive, and the total weight was 9,250lbs (4,200kg).

Opposite: A Dambusters' Lancaster. Note the configuration of the tail against which Plt Off A.F. Burcher DFM RAAF injured his back escaping from the fuselage door at the Möhne Dam

SQUADRON X

MARCH–APRIL 1943

With the bomb and planes in the works, it was finally time to assemble a team that was capable of the technically challenging task ahead

On 15 March 1943, C-in-C Bomber Command (Harris) tasked Air Vice-Marshal the Hon. R.A. Cochrane, commanding No. 5 Group, to raise a squadron for the Dams Raid. Two days later, Squadron X nominally came into being, and Cochrane learnt that, “the operation against this [Möhne] dam will not, it is thought, prove particularly dangerous, but it will undoubtedly require skilled crews ... Some training will no doubt be necessary.” Harris nominated Wing Commander G.P. Gibson, DSO, DFC & Bar (soon awarded a Bar to his DSO) as its commander, and on 18 March he agreed to take up the command.

Squadron X began to gather on 21 March at RAF Scampton, where one squadron had recently moved out, leaving only 57 Squadron in residence. At intervals during the next 10 days, 21 crews would arrive or be formed there. Not all arriving crews were complete; several had not even finished one tour, and many aircrew were posted to Scampton as individuals. The vast majority of the newcomers were undecorated, including six pilots.

Gibson and Flight Lieutenant D.J. Shannon were among those to complete their crews at Scampton; both came with only a navigator. As squadron commander, Gibson chose very experienced unattached personnel. Shannon

acquired a bomb-aimer (with just 12 operations flown) and a flight engineer, who approached him from 57 Squadron, because their pilot was sick; but he did not get a permanent wireless operator until 20 April. Sergeant W.C. Townsend lacked a wireless operator on arrival and Flight Sergeant G.A. Chalmers agreed to join the all-NCO crew unaware, as were they, that the navigator had been recently commissioned. Two of New Zealander Flight Lieutenant J.L. Munro's crew declined to transfer with him, though replacements were found before reaching Scampton.

Shannon and other former 106 Squadron pilots like Flight Lieutenant J.V. Hoppood and Flight Sergeant L.J. Burpee were among those personally chosen by Gibson. Flight Lieutenant H.B. Martin, an experienced Australian serving in the RAF and an acknowledged low-flying expert, answered Gibson's invitation by phone positively and brought his own crew to Scampton. So did the American Flight Lieutenant J.C. McCarthy, who had just completed a tour.

However, Bomber Command's hope of volunteers, who had completed or nearly completed two tours, would not be realised. Sergeant S. Oancia, Flight Sergeant K.W. Brown's bomb-aimer, mused, “I do not recall volunteering for this transfer,” a sentiment Brown's flight engineer warmly endorsed. The



WING COMMANDER GUY GIBSON (1918–44)

Guy Penrose Gibson joined the RAF in 1936 and in the opening phase of the war completed a bombing tour on Hampdens with 83 Squadron at RAF Scampton. Then, following 99 operations on night fighters with 29 Squadron, in April 1942 he took command of 106 Squadron, and flew a second bombing tour. At its conclusion, still only 24 years old and with a DFC & Bar and DSO & Bar, he was chosen by Air Chief Marshal Harris to lead 617 Squadron. He had to train it for its unique operation in under three months. Conscious of the pressure of time, and the need for efficiency and security, he insisted on high standards. Gibson replaced one crew and another opted to leave, rather than let him change its navigator. After the Squadron's armament officer returned from a course with more knowledge of the forthcoming operation than himself, he wrote a furious complaint to 5 Group. On the night, he not only directed the attacks on the Möhne and Eder dams, but drew fire on himself as a diversion once he had dropped his own Upkeep, and was subsequently awarded the VC. He was killed in a Mosquito on 19 September 1944, while returning from a raid on Rheydt during which he had again directed bombers on to their target.



“ON 24 MARCH, HUMPHRIES DECLARED SQUADRON X EFFECTIVE. THREE DAYS LATER, GIBSON RECEIVED “MOST SECRET” ORDERS AND THE SQUADRON’S IDENTITY: NO 617 SQUADRON”



FLIGHT LIEUTENANT J.C. MCCARTHY (1919-98)

Joseph Charles McCarthy, generally known as "Joe", was an American citizen, who before Pearl Harbor crossed the Canadian border to enlist in the RCAF, and wore twin shoulder flashes "USA" and "Canada". He was physically tall with a commanding personality. Intensely loyal to his crew, on arrival at Scampton he persuaded Gibson to grant its members four days' leave so that the bomb-aimer, Sergeant G. Johnson, could get married. Johnson later expressed his deep gratitude to McCarthy for bringing him back from 40 operations "without a scratch". McCarthy was justifiably meticulous about the maintenance of his aircraft, as one NCO later observed: "Joe McCarthy frightened me. If there was anything wrong he always held the electrical NCO responsible - and would seek him out for retribution the second he landed." After discovering an engine malfunction in his Lancaster

during pre-flight checks on 16 May 1943, McCarthy took off in the reserve machine long after other aircraft bound for the Sorpe Dam, but with determination pressed on alone to bomb the target. Already holding a DFC, to which a bar would be added in 1944, McCarthy gained a DSO after Operation Chastise.



four crews of 57 Squadron's C Flight were simply posted across the station, despite the vigorous protests of one of them. Pilot Officer W.H.T. Ottley, though, engineered a posting for his crew, on hearing the new squadron would be led by Gibson, but did not reach Scampton until 6 April. So instead of 21 crews, the Squadron had 22.

Gibson appointed Squadron Leader H.E. Maudslay (from 50 Squadron) and Squadron Leader H.M. Young (from 57 Squadron) as his flight commanders, rejected the appointed adjutant and replaced him with Flying Officer H.R. Humphries (who had been on the staff when Gibson commanded 106 Squadron). Meanwhile, Flight Sergeant G.E. Powell sorted out the ground crew, sending "scruffy buggers" back to their previous squadrons.

On 24 March, Humphries declared Squadron X effective, despite most of its crews not yet being on base. Three days later, Gibson received "most secret" orders and the Squadron's identity: "No 617 Squadron will be required to attack a number of lightly defended targets ... These targets will necessitate low level navigation over enemy territory in moonlight with a final approach to the target at 100ft at a precise speed, which will be about 240mph."



Opposite-top-right: Australian survivors. Pilots Flt Lt D.J. Shannon (3rd left), Flt Lt H.B. Martin RAF (3rd right), Plt Off L.G. Knight (2nd right). Plt Off F.M. Spafford (4th right) was in Gibson's crew

Opposite-bottom-left: Royal Canadian Air Force (RCAF) survivors. Pilots F/Sgt K.W. Brown and Flt Lt J.C. McCarthy (standing 4th left and 2nd right). F/Sgt G.A. Deering (standing 5th right) and Plt Off H.T. Taerum (crouching 2nd left) from Gibson's crew

Above: The Australian members of Flt Lt H.B. Martin's crew. (L to R) Flt Lt J.F. Leggo, F/Sgt T.D. Simpson, Flt Lt R.C. Hay, Plt Off B.T. Foxlee, Flt Lt H.B. Martin RAF. Plt Off I. Whittaker RAF and Fg Off L. Chambers RNZAF completed the crew. (Foxlee already had the DFM and did not receive a bar for this operation. Whittaker and Chambers were also undecorated)

Left: New Zealanders Fg Off L. Chambers (left) and Flt Lt J.L. Munro, who both flew on Operation Chastise

Top-left: Flt Lt J.C. McCarthy being presented to King George VI with Gibson left, AVM Cochrane (half hidden) right. In the distance, Queen Elizabeth speaks to Flt Lt D.J. Shannon

TABLE 1.

h_1	d_1
6'-7"	3'-9½"
6'-9"	3'-10½"
6'-11"	3'-11¾"
7'-1"	4'-1"
7'-3"	4'-2¼"
7'-5"	4'-3¼"
7'-7"	4'-4½"
7'-9"	4'-5½"

TABLE 2.

h_2	d_2	d_3
6'-7"	10¾"	5'-6½"
6'-9"	11"	5'-8¼"
6'-11"	11¼"	5'-10"
7'-1"	11½"	5'-11½"
7'-3"	11¾"	6'-1"
7'-5"	12"	6'-2¾"
7'-7"	12¼"	6'-4½"
7'-9"	12½"	6'-6"

$$d_1 = [(h_1 + 1") \times \tan 30^\circ - 0.7"] \text{ feet.}$$

$$d_3 = [(h_2 + 1") \times \tan 40^\circ - 0.7"] \text{ feet.}$$

$$d_2 = (h_2 + 1") \times \frac{d}{100} \text{ feet.}$$

ITEM 08**NOTES ON THE SPOTLIGHT
ALTIMETER CALIBRATOR**

Calculations and directions connected with the fitting of two Aldis lamps to the Lancasters modified for the Dambusters raids for establishing Upkeep's release height of 60 feet (18.3 metres). Devised by Ben Lockspeiser, Director of Scientific Research at the Ministry of Aircraft Production, these are jottings of his early thoughts. The word "spotlight" has become misleading, "the other near the tail" also misinterpreted. The two positions, as shown, were (front) in the camera slot, (rear) at the back of the bomb-bay, but with the beams angled to meet forward of the leading edge of the starboard wing.

ITEM 09

EXTRACTS FROM THE TARGET FOLDER FOR THE MÖHNE DAM

The original target folders for each dam contained all the available information – dimensions, construction, location, defences and other relevant details. This is an extract for that on the Möhne Dam, near Soest (target no. GO 939). The Air Intelligence summary, 12 February 1943, explains how the adjacent reservoir is fed from two rivers, how the water is drawn off, and the function of the two power stations on the air side of the dam. The cross-section diagrams illustrate the working of the machinery. The road passing over the crest of the dam beyond the trees can be seen in the undated pre-war photograph. The protective double torpedo boom and Guenne village beyond the equalising basin can be seen in the 19 February 1943 reconnaissance photo.

OP. No. GO 939

A.M. No. 1(j)9

PLACETARGET MOINE DAM

SECRET

TARGET FOLDER

NAME OF PLACE

GUINNE nr. SOEST

NAME OF TARGET

MOINE DAM

TARGET OPERATIONAL NUMBER

GO 939

AIR MINISTRY NUMBER

1(j)9

A.I.3c (1)
AIR MINISTRY

SECRET.

NOT TO BE TAKEN INTO THE AIR

COUNTRY: GERMANY

INFORMATION SHEET DATED 12.2.43.

<u>OP. NO.</u>	GO 939	<u>PLACE:</u> GUNNE nr. SOEST (Mohne Dam)	<u>LAT.:</u>	51° 29' N.
<u>A.M. NO.</u>	1 (j) 9	<u>CATEGORY:</u> POWER	<u>LONG:</u>	08° 04' E.
<u>DISTRICT TARGET</u>		<u>SUB-CATEGORY:</u> DAMS	<u>ALT.:</u>	700 feet approx.
<u>MAP NO.:</u>	-			

ALL PREVIOUS INFORMATION SHEETS AND AMENDMENTS THERETO ARE CANCELLED.

TARGET MAP: Standard 1941 (magnetic) map dated February 1943.

DESCRIPTION: The target is the MOHNE DAM and HYDRO-ELECTRIC POWER STATION at GUNNE, 6½ miles S.S.W. of Soest and 25 miles east of Dortmund. It is situated at the north west corner of the reservoir known as the MOHNE-TALSPERRE, which extends eastwards from the dam for about six miles and south and east for about three and a half miles.

The dam has a storage capacity of at least 130,000,000 cubic metres and was built to improve the flow of the River Ruhr, by controlling the water shortage in the Ruhr valley during summer and autumn, so that the numerous pumping stations which provide water for the towns of the Rhine-Westphalian area and for the hydro-electric plants along the river may be supplied with adequate water even during very dry periods. The target is therefore of vital importance to the whole Ruhr valley and its destruction would not only cause disastrous flooding, but would upset water supplies over a large part of the most highly industrialised area in Germany.

The reservoir is fed by two rivers, the Mohne, which enters at the eastern end of the northern arm, and the Heve, which enters at the eastern end of the southern arm. The water is carried off by the Mohne valley westwards of the dam and enters the Ruhr at Neheim, five miles to the south west.

The wall of the dam is of limestone rubble masonry and is specially protected against the seepage of water. It is carried at least 6½ feet into the rock at its base and is built in a curve which permits a good joining of the ends of the wall to the sides of the valley. To carry off the water overflowing when the reservoir is full the crest has been built as an "overfall", i.e. with a series of arched openings discharging on to a downstream apron (See Illus. 1 (j) 9/7).

The water is normally drawn off by means of four pipes of 4.62 ft. diameter carried in pairs through culverts in the foot of the dam. Each pipe has two valves controlled from the crest of the dam and operated by electric power or by hand. The control rooms are in the round chambers built on either side of the two gabled towers on the top of the wall. Each pipe has also a third valve in the valve chambers which are built on to the downstream side of the dam. The pipes fork in the four valve chambers, one branch of each serving to discharge the water directly into the Mohne and the other carrying it to the power station (see Illus. 1 (j) 9/9). In addition there are ten emergency discharge pipes for carrying off the heaviest floods.

The 6,000 kw. power station, situated immediately below the dam, is operated by the Vereinigte Elektrizitätswerke Westfalen A.G. (V.E.W.) and is equipped with two driving turbines, a main turbine of 2,200 h.p. and an auxiliary turbine of about 1,000 h.p. maximum output.

Below the power station is an equalizing basin which receives the water from the power station and passes it on to a subsidiary 500 k.w. power plant, whence it is finally discharged into the channel of the Mohne.

TECHNICAL SUMMARY.

Height from valley floor	105 feet	32 metres
" " rock bottom	130 feet	40.3 metres
Length	2,100 feet	650 metres
Thickness at top	25 feet	7.9 metres
" " bottom	112 feet	34.2 metres
Water content	134,000,000 to 140,000,000 cubic metres (various estimates)	
Surface of dammed water	10.4 square kilometres	
Max. Height of dammed water	105 feet	32 metres

VULNERABLE POINTS:

DECOYS:

The nearest decoys are SOEST I (BREMEN), HAMM 2 (HAMM SUD) and HAMM 3 (MARK) positions of which are given in the information sheet for target GH.444.

CAMOUFLAGE:

None reported.

FURTHER INFORMATION:

ILLUSTRATIONS:

(All Illustrations NOT mentioned below are cancelled)

- 1 (j) 9/1 - Ground photograph, looking S.S.W.
- 1 (j) 9/5 - Oblique photograph looking west.
- 1 (j) 9/6 - Ground photograph, looking east.
- 1 (j) 9/7 - Ground photograph showing valve chambers, etc.
- 1 (j) 9/8 - Oblique photograph, looking S.E.
- 1 (j) 9/9 - Section and plan
- 1 (j) 9/10 - General plan of target.

FILING INSTRUCTIONS:

NOT TO BE TAKEN INTO THE AIR.

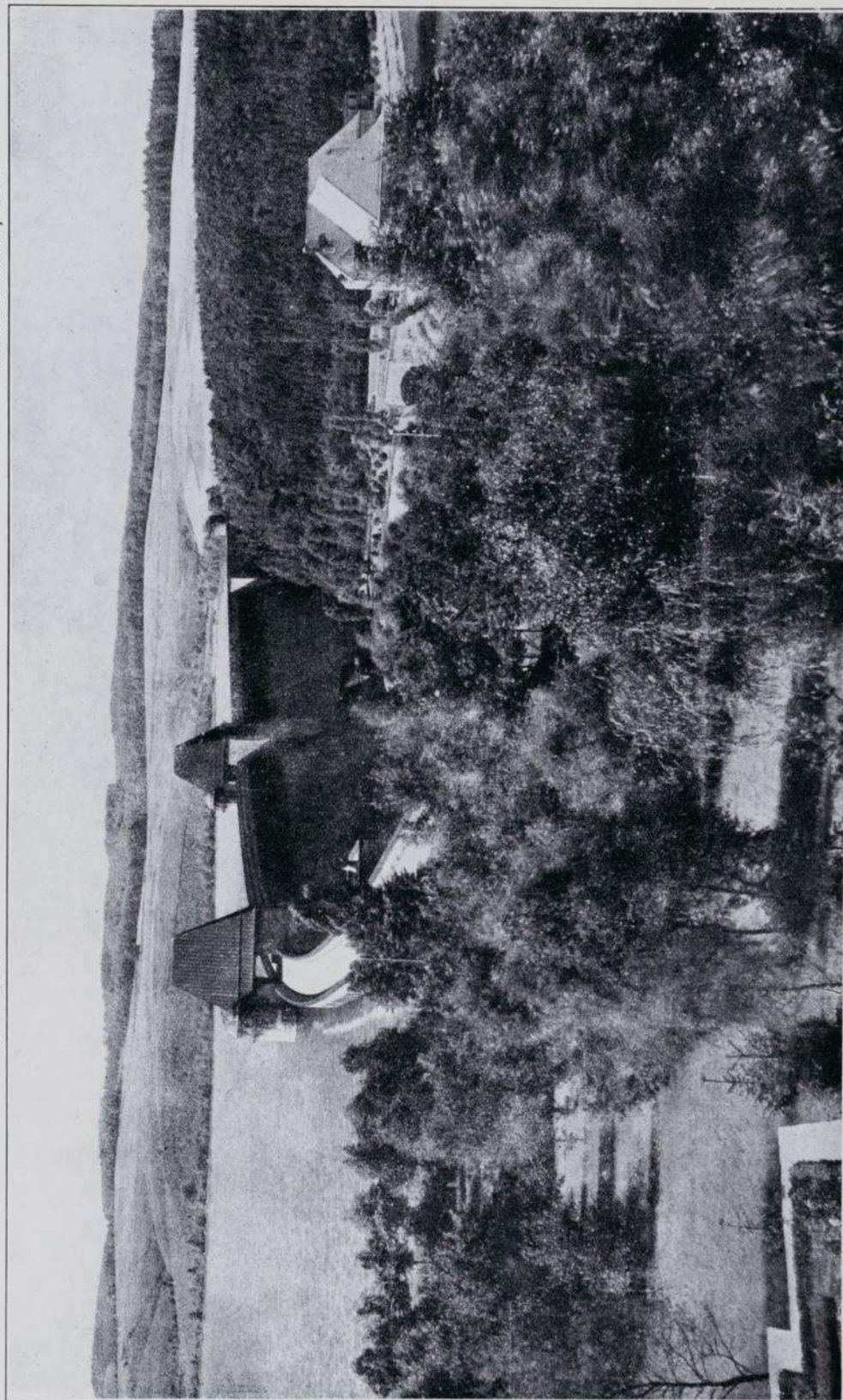
Target No.
I (j) 9

Illustration No.
I (j) 9/1

MÖHNE DAM — GÜNNE near SOEST (GERMANY)
G.S.G.S. 4416. Sheet Q2.
RB 226214. Lat. $51^{\circ} 29' N$.
Long. $08^{\circ} 04' E$.

Pre-war photograph, date unknown

Re-issued January 1945



LOW OBLIQUE VIEW, LOOKING S.S.W.

Photographed before breaching of dam on 16/17 May 1943 when Power Station
on right of picture was demolished.

A.13c(1)

TYPE B

60 939
Illustration No.
I (j) 9/1

NOT TO BE TAKEN INTO THE AIR.

Target No.
I (j) 9

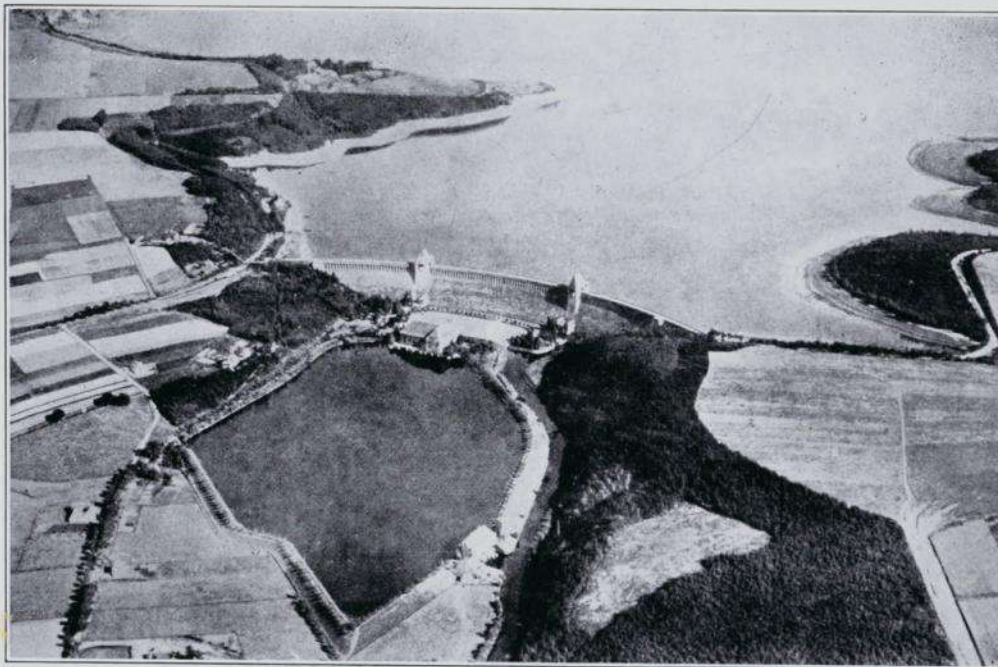
MÖHNE DAM —
G.S.G.S. 4416. Sheet Q3.
RB 226214.

GÜNNER near SOEST (GERMANY)
Lat. 51° 29' N.
Long. 08° 04' E.

Illustration No.
I (j) 9/8

Photographed 1930

Re-issued January 1945



HIGH OBLIQUE VIEW, LOOKING SOUTH-EAST.

Photographed before breaching of dam on 16/17 May 1943 when Power Station at foot of dam was destroyed.
Equalizing Basin now (Jan. 1945) emptied.

A.I.3c (1)

TYPE B

Target No.
I (j) 9

MÖHNE DAM —
G.S.G.S. 4416. Sheet Q3.
RB 226214.

GÜNNER near SOEST (GERMANY)
Lat. 51° 29' N.
Long. 08° 04' E.

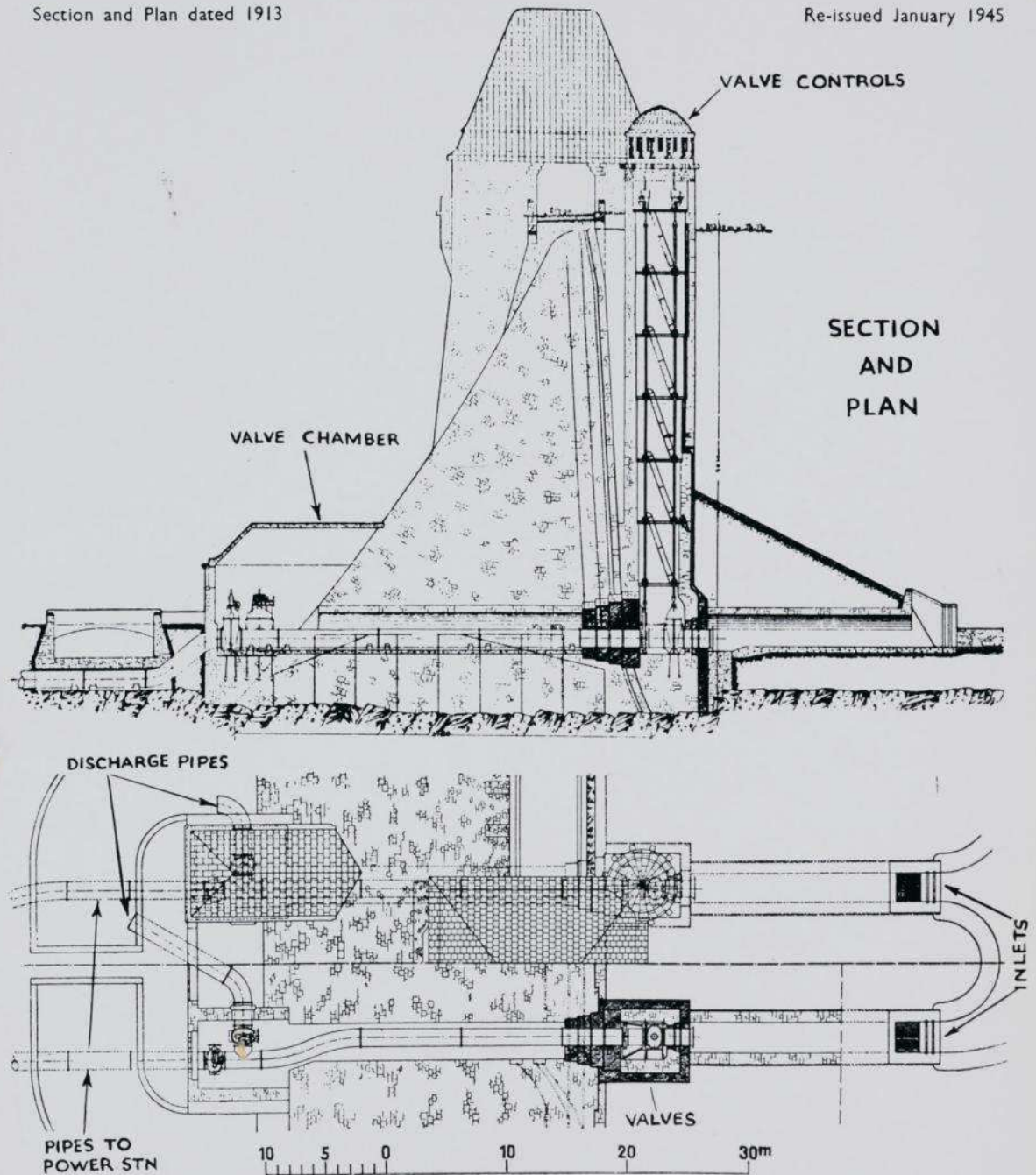
NOT TO BE TAKEN INTO THE AIR.

Illustration No.
I (j) 9/9

(1 : 465) approx.

Section and Plan dated 1913

Re-issued January 1945



SECTION AND PLAN THROUGH VALVE CONTROL TOWERS.
Roofs of Towers now removed.

A.I.3c (1)

TYPE B

NOT TO BE TAKEN INTO THE AIR.

Target No.
I (j) 9

MÖHNE DAM —
G.S.G.S. 4416. Sheet Q 3.
RB 226214.

GÜNNE near SOEST (GERMANY)
Lat. 51° 29' N.
Long. 08° 04' E.

Illustration No.
I (j) 9/11

0 500 1000 1500 2000 2500 3000 FEET
0 1 2 MILE

Photographed 19 February 1943

(1 : 9,600) approx.

Re-issued January 1945



Photographed before breaching of dam on 16/17 May 1943.
See illustration /13 for post-raid cover.

A.I.3c (1)

TYPE B

TRAINING

APRIL–MAY 1943

With just weeks to go until the scheduled raid and no opportunity to practise in the real Ruhr Valley, 617 Squadron's training began

Gibson had been advised that, in preparing for a low-level attack, "it will be convenient to practise this over water" and that crews should be able to release their "mine" within 40 yards (37 metres) of a specified point.

No modified aircraft had yet arrived and only 10 standard Lancasters were available for the 22 crews. As the operation would take place at night, crews were required to wear dark glasses during daylight training, with a second pilot standing by in case of emergency. Lengthy cross-country routes were planned to incorporate low-level runs over nine selected lakes, other canals and rivers.

Training was rigorous. By mid-April, one crew, which "did not come up to the standard necessary for this squadron", had returned to 57 Squadron, which provided a replacement. Another crew opted to leave, when Gibson proposed to replace the navigator. So 21, not 22, crews were on strength.

Gibson had visited Wallis twice and been more fully briefed by Cochrane. He learnt that aircraft would release their bombs at 150 feet (46 metres) after diving from 2,000 feet (610 metres). He was also told the identity of the targets and their importance to German industry. Cochrane emphasised the need for the utmost security; not even his flight commanders were to know about Upkeep or the dams.

Bombing exercises were carried out with standard practice bombs at the Wainfleet range on The Wash. A special procedure was devised at Scampton, where Lancasters dived steeply towards a tarpaulin spread on the ground

RAF SCAMPTON

RAF Scampton lies six miles (10 kilometres) north-west of Lincoln. Opened in 1916 as Brattleby, the following year it assumed the name of the nearby village. Before becoming a training base in the closing months of the First World War, it housed FE2b aircraft (a two-seater pusher biplane) as part of the Royal Flying Corps' defence against German airships. Closed in 1919, Scampton was reopened and expanded in 1936 as a bomber station, and three years later Nos 49 and 83 Squadrons of No. 5 Group were stationed there; in the latter, Flight Lieutenant Gibson completed his first bombing tour. The station continued to operate two squadrons from its grass runway, but in March 1943 one had moved out so that hard runways could be installed. 617 Squadron was therefore able to occupy its vacant accommodation and join 57 Squadron, which would boost the new squadron's complement by its entire C Flight of four Lancaster crews and personnel

like Flight Lieutenant Shannon's bomb-aimer and flight engineer (who volunteered to transfer). In the Second World War, 617 Squadron flew only Operation Chastise from Scampton, but post-war during the Cold War period it would return equipped with the Avro Vulcan nuclear bomber.



and flew across the grass at 150 feet (45 metres), before pulling up sharply on reaching a second tarpaulin.

At the end of April, Gibson reported to the station commander, Group Captain J.N.H. Whitworth DSO DFC, that all crews could safely navigate from pinpoint to pinpoint at low-level by night, fly low over water and use a special sight to bomb accurately. Photographic reconnaissance had revealed that two towers on the Möhne Dam were approximately 700 feet (210 metres) apart, and cricket sight

screens were erected accordingly at Wainfleet. Using calculations based on this distance, a triangular wooden contraption with a peep-hole at its apex and two nails at the ends of the base was fashioned for the bomb-aimer to hold. When nails and sight screens coincided, the practice bombs were released.

The first modified Lancaster reached Scampton on 8 April, and 11 more arrived by the end of the month. Another innovation allowed the dark glasses to be discarded. Synthetic Night Flying Equipment (blue



THE EYEBROOK RESERVOIR

Situated close to Uppingham in Rutland, and sometimes named "Uppingham Reservoir" or "Corby Lake" in Operation Chastise documents, the Eyebrook reservoir supplied water for the nearby Corby steel works. With a straight wall at its southern end and usually full in May, it provided an ideal practice target. The responsible authority, the Corby (Northants) & District Water Company, gave permission for 617 Squadron aircraft to practise over it, provided "they will drop nothing, and fire nothing, and damage nothing." On 4 May, "four special canvas targets, approximately 20ft x 12 ft ... were fixed in barrels of concrete on top of the dam." Grouped in twos and linked together with camouflage netting, they simulated the towers on the Möhne. That afternoon, the Lancasters began to fly low over the structure, firing "purple flares" as they crossed it. One of the dummy towers was blown down and, on 11 May, was re-erected by water company workmen under RAF supervision. Three nights later, the Eyebrook reservoir doubled for the Möhne Dam during the final exercise along a route designed to resemble that to the Möhne and Eder dams on the operation. Afterwards, Air Vice-Marshal Cochrane wrote to the manager of the water company in order to thank him for his invaluable co-operation.

celluloid panels fitted to the cockpit, bomb-aimer's and rear gunner's positions) was installed in two Lancasters, which involved crewmembers wearing amber goggles during simulated night flights.

Maintaining a low level over water proved hazardous, but the MAP scientist Benjamin Lockspeiser provided a solution. An Aldis lamp was fitted in the redundant front camera spot, and another in the rear of bomb-bay, whose doors had been removed. The beams were angled to meet on the surface of the water forward of the starboard wing, to enable the aircraft to be flown at low-level. From 26 April, crews were ordered to bomb from 60 feet (18 metres), rather than 150 feet (46 metres) at 210mph (338kph) true airspeed, and in doing so they achieved an average error of 39 yards (36 metres).

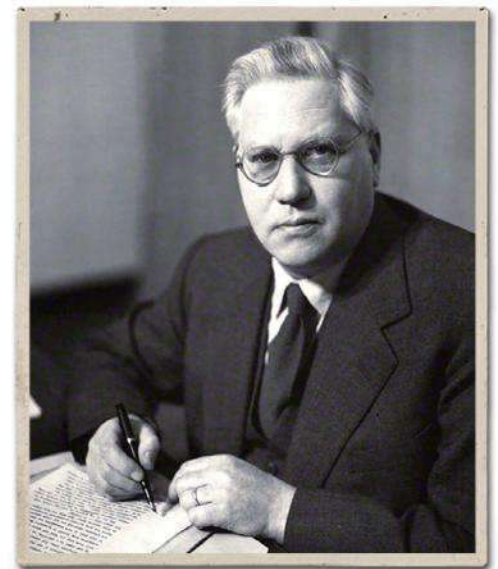
To achieve this accuracy, some crews had dispensed with the wooden sight and worked out their own method, involving string attached to the butterfly nuts retaining the clear vision panel and drawn back to the bomb-aimer's eye, or marks on the panel itself. From 4 May, canvas screens, simulating the Möhne towers, were put up at the Eyebrook reservoir near Corby for crews to train there. As they did so, Gibson declared 617 Squadron "ready to operate".

In truth, though, no crew had yet seen Upkeep, let alone practised with it.

Opposite-bottom: A modified Lancaster used for the trials at RAF Boscombe Down. Note it has no mid-upper turret and no bomb-bay doors. It was flown as AJ-T by Flt Lt J.C. McCarthy to the Sorpe Dam

Bottom: Derwent Water Dam in the Peak District, Derbyshire. Between the Derwent and Lady Bower reservoirs, this was one of the locations used for practice by 617 Squadron before the raid

Below: Benjamin "Ben" Lockspeiser (1891-1990), a Cambridge science graduate, devised the converging Aldis lamp arrangement for the Dambusters' Lancasters. Knighted in 1946, he was an accomplished pianist and orchestral conductor



"CREWS WERE REQUIRED TO WEAR DARK GLASSES DURING DAYLIGHT TRAINING, WITH A SECOND PILOT STANDING BY IN CASE OF EMERGENCY. LENGTHY CROSS-COUNTRY ROUTES WERE PLANNED TO INCORPORATE LOW-LEVEL RUNS OVER NINE SELECTED LAKES, OTHER CANALS AND RIVERS"



FINAL TRIALS

APRIL–MAY 1943

With only three weeks to go, the final trials with the bouncing bomb were performed – but the results were not promising

The last trials at Chesil Beach took place on 8–9 March, before the scene moved to the north Kent coast. Two of the modified Lancasters flew to RAF Manston. From there, trials would take place to determine “the range and the trajectory of the large store (Upkeep) with particular reference to the heights and speed considered suitable by the Air Staff”. The aircraft would fly east to west parallel to the shore across Reculver Bay, which was dominated by the twin towers of an old Norman abbey church on a promontory. Captains J. “Mutt” Summers and R.C. Handasyde (Vickers-Armstrongs’ test pilots), Squadron Leader M.V. Longbottom (on secondment to that firm) and Captain H.A. “Sam” Brown (Avro test pilot) would carry out the trials.

Using the Wellington from Chesil Beach, on 13 April Handasyde dropped an inert-filled Upkeep from 80 feet (24 metres). The outer packing broke away, but the internal cylinder bounced on “remaining stable until the end of its run”. Later that day, Longbottom twice used a Lancaster: the first drop from 250 feet (75 metres) was unsuccessful, the second from 50 feet (15 metres) more promising. Although the surrounds shattered, the cylinder again ran on.

More trials took place on 18 April. Three flattened spheres were dropped by Summers, the cylinder from one breaking free to travel an estimated 700 yards (640 metres). This was the third time this had happened. After consulting Professor G.I. Taylor (a member of the AAD Committee present), Wallis decided to dispense with the outer packing and use

just the metal charge cylinder. Four days later, Brown dropped the first bare cylinder from low-level and on 23 April another from 185 feet (55 metres). Both efforts failed. The following day, 24 April, with the attack on the dams scarcely three weeks away, Gibson and Wallis met at Brooklands. Wallis explained that the height of release must be lowered to 60 feet (18 metres).

On 29 April, Gibson was among observers, who watched Longbottom drop an Upkeep cylinder rotating at 500rpm from 50 feet (15 metres). It bounced six times over 670 yards (610 metres) and veered slightly off-track towards the end. The following day, another dropped by Longbottom from 65 feet (20 metres) at 218 mph (351 kph) in flat calm, bounced four times over 435 yards (397 metres). Despite deviation of 50 feet (15 metres) to the left, Wallis believed this “a very good performance”. He was now satisfied that the cylindrical Upkeep would work. RAF officers were less sure. On 2 May, they called for five more cylinders to be dropped from 60 feet (18 metres) between 210 and 220mph (338 and 354kph) groundspeed and spinning at 500rpm.

Meanwhile, range and manoeuvrability tests were being carried out with the third modified Lancaster allocated for trials at the Aeroplane and Armament Experimental Establishment (A&AEE), Boscombe Down. Climbing, diving and stalling tests were satisfactorily completed at an indicated air speed of 160mph (257kph). Not knowing the nature of the planned operation, the A&AEE report calculated that an outward flight with the bomb at 2,000 feet (610 metres) and return without it at 15,000 feet





(4,500 metres) would give a still-air range of 1,720 miles (2,770 kilometres); ample margin even for higher fuel consumption at low-level.

During the first week of May, the additional trials required by the RAF were carried out at Reculver; these flights were not parallel to the shore, but at right angles to it with flags simulating the Möhne towers mounted on the beach below the promenade. On 7 May, Wallis recorded, "Shorty (Longbottom) did two good drops – direct hits." Four days later, Longbottom once more flew parallel to the shore dropping two more trial weapons, which bounced five and six times a distance of 430 yards (395 metres) and 460 yards (420 metres) respectively without deviation.

The omens, therefore, were good. But, thus far, 617 Squadron crew had not practised at Reculver and no live Upkeep had yet been dropped by anybody.

Opposite-bottom-centre: Joseph "Mutt" Summers CBE (1904–1954), was a retired RAF pilot and Vickers-Armstrongs' chief test pilot. He tested over 366 aircraft types including the Spitfire and Wellington prototypes

Opposite-bottom-left: Robert Cruickshank "Bob" Handasyde (1908–79), was the son of pioneer aircraft designer, George Handasyde. He became a Vickers test pilot and post-war sales manager at Vickers-Armstrongs in Weybridge

Opposite-right: Stills images from the practice drop by modified

"WALLIS DECIDED TO DISPENSE WITH THE OUTER PACKING AND USE JUST THE METAL CHARGE CYLINDER. FOUR DAYS LATER, BROWN DROPPED THE FIRST BARE CYLINDER FROM LOW-LEVEL AND ON 23 APRIL ANOTHER FROM 185 FEET. BOTH EFFORTS FAILED"

Lancasters at Reculver before the outer casing was removed. Note the shape of Wallis's original bomb design and how it bounces before the bomb sinks clear

Top and above, left: The type 464 Provisioning Lancaster during practice. Both images show the calliper arms in position. The starboard belt drive is visible in the left image

Above-right: Barnes Wallis (left) in usual office attire of sports jacket, with his personal assistant, A.D. Grant who used stopwatches to time bounces during pre-operational trials

THE RECVLVER TRIALS

At the beginning of March 1943, a range off the north Kent coast in Reculver Bay was chosen for further dropping trials, with the test aircraft flying from RAF Manston. The area was secluded, with agricultural land sloping southwards towards the water and no private houses in the vicinity. Vickers test pilot R.C. Handasyde surveyed the area in the Chesil Beach Wellington on 9 April. The following evening, Wallis landed at Manston in one of the modified Lancasters, piloted by "Mutt" Summers, to brief Vickers-Armstrong staff about the forthcoming trials. Inert-filled practice Upkeeps with their central cylinder, additional packing outside and retaining wooden exterior were loaded at the RAF station by service personnel under the supervision of Vickers-Armstrongs staff. At the range itself, on shore Vickers-Armstrongs staff recorded the performance of each weapon being dropped. Between 13 April and 1 May, four sets of trials were conducted parallel to the shore at Reculver, after the second of which (18 April) Upkeep was stripped to its bare cylinder. In the first two weeks of May, the test pilots, followed by 617 crews, attacked the simulated towers below the promenade at 90 degrees. Then, 11–12 May, the test pilots flew the final practice trials parallel to the Reculver shore prior to live drops off Broadstairs on 13 and 15 May.

LATE DRAMA

12–14 MAY 1943

In the countdown to the raid on the Ruhr, last-minute problems plagued the Squadron, while the Royal Navy sought to end the attack altogether

Not until 11 May, five days before the operation, did three 617 crews drop an inert-filled Upkeep at right angles to the Reculver promenade towards the flags representing the Möhne towers. Of his own effort, Gibson recorded: “Low level Upkeep dropped at 60ft. Good run of 600yds.”

The following day, more crews repeated the exercise; the sight of Upkeep bouncing over the water and rolling up the beach vividly impressed Pilot Officer L.G. Knight’s navigator, Flying Officer H.S. Hobday. But the flights on 12 May revealed a problem. Without using the converging Aldis lamps, it was difficult to judge height, and the tailplane of Flight Lieutenant Munro’s aircraft sustained damage. The following day, Squadron Leader Maudslay’s machine suffered similarly, being classified “badly damaged”. Both needed urgent workshop attention. Four others, less seriously damaged, were quickly repaired. The fourth day’s practice at Reculver, on 14 May, passed without significant mishap. However, if the Lancasters of Munro and Maudslay proved irreparable, there would only be 18 aircraft for 21 crews; the twentieth modified machine reaching Scampton on 15 May.

An exercise on 4 May had uncovered serious communication problems in the air and the radio equipment had rapidly to be replaced. During the evening of 14 May, many, but not all,

of the crews unknowingly took part in the final cross-country exercise over a route designed to resemble that to the Möhne and Eder Dams. In his log book, Gibson wrote: “Full dress rehearsal on Uppingham Lake and Colchester reservoir. Completely successful.”

At this late stage, the method of attack on the Sorpe remained undecided. Absence of towers threw doubt on Wallis’s idea of a right-angle approach and Cochrane raised the pre-war suggestion of bombing the top of the dam.

After receiving the draft operation order from Group Captain H.V. Satterly at 5 Group headquarters on 10 May, Gibson had drawn up his order of battle, allowing for 20 crews divided into three waves with one crew in reserve. This distribution was severely disrupted, when two crews were subsequently ruled out through illness, forcing Gibson to deploy the reserve crew and reorganise the different waves.

All of this might have been in vain, because the Dams Raid faced a last-minute veto by the Royal Navy. A smaller version of the bouncing bomb (codenamed Highball) had been under development so that 618 Squadron flying Mosquitoes could attack the German battleship Tirpitz in a Norwegian harbour. Highball had not yet been perfected, and naval officers were afraid that if Operation Chastise went ahead independently the technique would be compromised.

617 SQUADRON AT RECULVER

During the second week of May, with the 19 May time limit for Operation Chastise imminent, 617 crews began to practise at the Reculver Bay bombing range off the north Kent coast. Like the test pilots shortly before them, on 11 May three 617 crews (including Gibson’s), flying inland from the Thames estuary, attacked at right-angles flags attached to poles beneath the promenade simulating the Möhne towers. More crews did so the following day and, on 13 May, Gibson reported that the Squadron had executed “several successful drops” with inert-filled Upkeeps, and had experienced “no difficulty” in maintaining “the correct height of 60 feet”. On 14 May, 617 crews again dropped practice Upkeeps at Reculver, and Wallis praised their ability “to put stores (Upkeeps) on the beach with remarkable accuracy.” But the fact remained that on the day that the twentieth modified Lancaster was delivered to Scampton (13 May), with two severely damaged aircraft, only 18 could be guaranteed for 21 crews. The raid was just three days away.



The final decision rested with the Chiefs of Staff, then 3,000 miles (4,800 kilometres) away in Washington. During the afternoon of 14 May, the Air Ministry received a critical signal: "Chiefs of Staff agree to immediate use of Upkeep without waiting for Highball." Just 48 hours remained before take-off.

Left and below: Two photos showing Upkeep being dropped off Reculver, and the Lancaster flying clear before the weapon reaches its first bounce height of 30 feet (nine metres)

Bottom: The practice Upkeep bounces accurately towards the simulated Möhne towers below the promenade at Reculver (hidden right) urged on by spectators (centre)

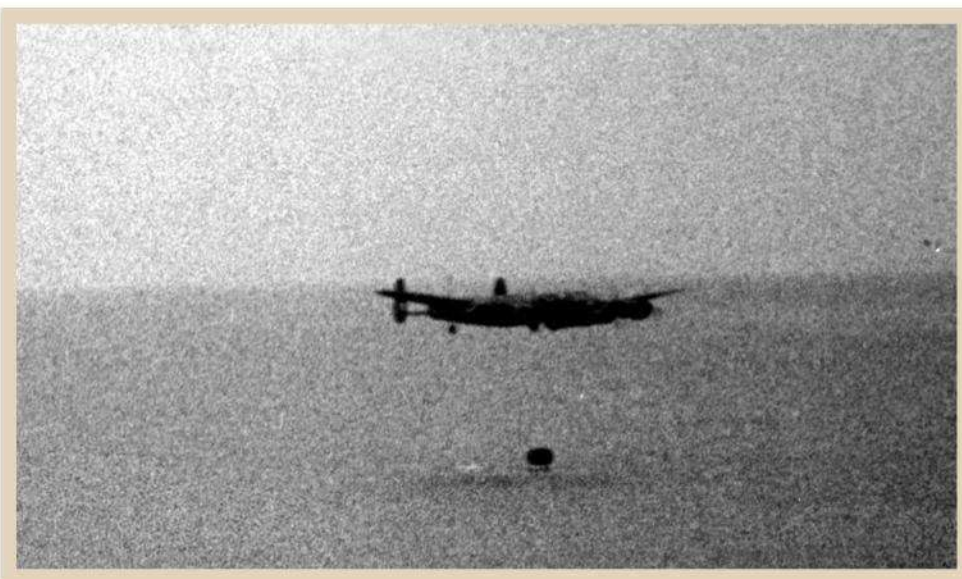
Opposite-bottom-left: A Lancaster releases a full-size, spinning Upkeep cylinder during a trial off Reculver

Opposite-bottom-right: The rusted remains of a practice Upkeep recovered from the sea off Reculver, which is currently on display at Dover Castle

"THE FLIGHTS ON 12 MAY REVEALED A PROBLEM. WITHOUT USING THE CONVERGING ALDIS LAMPS, IT WAS DIFFICULT TO JUDGE HEIGHT"

LIVE DROPS

Three days before the operation, no live drop of Upkeep had taken place. So on 13 May, flying five miles (8 kilometres) off Broadstairs on the east coast of Kent, Flight Lieutenant Longbottom released a Torpex-filled, fully armed Upkeep from 75 feet (23 metres). Cameras mounted ashore and in the second modified Lancaster flown by R. Handasyde at 1,000 feet (305 metres) and 1,000 yards (914 metres) behind recorded seven bounces over "almost 800 yards (731 metres)". The plume of water, which rose after the underwater explosion, reached an estimated 1,500 feet (457 metres). Gibson flew with Handasyde as an observer and an Air Staff officer, Group Captain W. Wynter-Morgan, was in Longbottom's rear gunner's position to see Upkeep slow to 55mph (88kph) after release. Barnes Wallis thought: "We obtained a 'dome' or rise of solid water about 20 feet (six metres) in height and 200 to 300 yards (183-274 metres) in diameter at the instant of detonation. This was followed by the 'plume' which arose to a height of about 750 feet (229 metres) and was probably between 100 and 200 feet (30-60 metres) in diameter." Doubts remained that if Upkeep hit the water too hard on release, it might detonate prematurely because the stability of Torpex in such a circumstance had not been tested. Hence, on 15 May (the eve of the raid), Handasyde flew off Broadstairs again to drop a Torpex-filled Upkeep without hydrostatic or self-destructive pistols inserted. It exploded neither in contact with the surface, nor underneath.



ITEM 10

DECISIVE CYPHER MESSAGE

The authorisation sent to Bomber Command from the Air Ministry on the morning of Saturday 15 May 1943 for an attack on the dams "at first suitable opportunity". This was duly forwarded to

No. 5 Group Headquarters at Grantham. That afternoon, A.V.M. Cochrane travelled to Scampton to inform the Station Commander and Wing Commander Gibson that the raid would take place the following night, provided conditions were favourable. Barnes Wallis reached Scampton that afternoon as well, just as the loading of his "bouncing bomb" onto the modified Lancasters commenced. Shortly afterwards, Gibson went to Grantham for a discussion of the final Operation Order.

OUTGOING CYPHER MESSAGE.

HEADQUARTERS BOMBER COMMAND

MOST

FROM AIR MINISTRY
WHITEHALL

DEGREE OF PRIORITY
MOST IMMEDIATE

FOR USE IN
A.M.C.S.

X

Passed to Typing
Received by Typing
Typed by
Received in Desp.
Despatched by
Scrutineer

INTLS.	TIME

TEXT OF MESSAGE.

MOST SECRET

Operation CHASTISE • Immediate attack of targets 'X', 'Y',
'Z' approved • Execute at first suitable opportunity •

COPIES TO :—

V.C.A.S.
A.C.A.S. (Ops.) Orig.
D.B. Ops.

TIME OF ORIGIN

0900Z

TRANSMISSION

(MAY be by W/T)
(MUST NOT be by W/T.)
(Delete whichever is not applicable.
(See Page 29 Staff Handbook Pt. II.)

(Sgd) V. E. DRY

Signature of Originator.

DATE 15.5.43.

RANK 7th A.V.M.

A.M. FILE
REFERS.

BRANCH A.C.A.S.
(Ops.)

MO S T S E C R E T

COPY NO. **4**....

NO. 5 GROUP OPERATION ORDER NO. B.976

APPENDIX 'A' - ROUTES AND TIMINGS.

APPENDIX 'B' - SIGNALS PROCEDURE FOR
TARGET DIVERSIONS, ETC.

APPENDIX 'C' - LIGHT AND MOON TABLES.

INFORMATION.

General.

1. The inhabitants and industry of the Ruhr rely to a very large extent on the enormously costly water barrage dams in the Ruhr District. Destruction of TARGET X alone would bring about a serious shortage of water for drinking purposes and industrial supplies. This shortage might not be immediately apparent but would certainly take effect in the course of a few months. The additional destruction of one or more of the five major dams in the Ruhr Area would greatly increase the effect and hasten the resulting shortage. TARGET Z is next in importance.
2. A substantial amount of damage would be done, and considerable local flooding would be caused immediately consequent on the breach of TARGET X. In fact it might well cause havoc in the Ruhr valley. There would be a large loss of electrical capacity in the Ruhr partly caused by destruction of hydro-electric plants, but also due to loss of cooling water for the large thermal plants.
3. In the Weser District the destruction of the TARGET Y would seriously hamper transport in the Mittelland Canal and in the Weser, and would probably lead to an almost complete cessation of the great volume of traffic now using these waterways.
4. The reservoirs usually reach their maximum capacity in May or June, after which the level slowly falls.

Enemy Defences.

5. (a) TARGET X.

There are three objects on the crest of this dam which may each be a light A.A. gun. A light 3-gun A.A. position is situated below and to the N. of the dam with a possible searchlight position nearby. A double line boom with timber spreaders is floating on the main reservoir at 100 to 300 feet from the dam. No other A.A. position or defence installation is known.

(b) TARGETS Y and Z.

Information about the defences of these two dams will be given when P.R.U. sorties have covered these areas. (Information has now been issued).

(c) The last resort targets are unlikely to be defended.

INTENTION.

6. To breach the following dams in order of priority as listed:-

- (a) TARGET 'X' (GO 939)
(b) TARGET 'Y' (GO 934)
(c) TARGET 'Z' (GO 960)
(d) Last Resort Targets:-
(i) TARGET 'D' (GO 938)
(ii) TARGET 'E' (GO 935)
(iii) TARGET 'F' (GO 933)

/EXECUTION

ITEM II

OPERATION ORDER

This final version was distributed on the morning of the raid. It outlined reasons for the operation, and emphasised that the Sorpe was next in importance to the Möhne Dam, as the Eder was not connected with the Ruhr. Twenty attacking aircraft were still envisaged with the Third Wave comprising six Lancasters. It noted that destruction of the Möhne "might require three effective attacks", and provision was made for the remaining First Wave machines to then attack the Eder and Sorpe dams. Overall details of the attacks were supplemented by specialised appendices (not shown), though the inward route for the First and Second waves would be modified during a Squadron conference at Scampton late on 15 May. (See also Item 1 - Official map showing the planned routes to and from the dams.)

EXECUTION:

Code Name.

7. This operation will be known by a code name which will be issued separately.

Date of Attack.

8. The operation is to take place on the first suitable date after 15th May, 1943.

Effort.

9. Twenty Special Lancasters from 617 Squadron.

Outline Plan.

10. The twenty special Lancasters of 617 Squadron are to fly from base to target area and return in moonlight at low level by the routes given in APPENDIX 'A'. The Squadron is to be divided into three main waves, viz:-

- (a) 1st Wave. Is to consist of three sections, spaced at ten minute intervals, each section consisting of three aircraft. They are to take the Southern route to the target area and attack Target X. The attack is to be continued until the Dam has been clearly breached. It is estimated that this might require three effective attacks. When this has been achieved the leader is to divert the remainder of this wave to Target Y, where similar tactics are to be followed. Should both X and Y be breached any remaining aircraft of this wave are to attack Z.
- (b) 2nd Wave. Is to consist of five aircraft manned by the specially trained crews who are to take the Northern route to the target, but are to cross the enemy coast at the same time as the leading section of the 1st wave. This 2nd wave are to attack Target Z.
- (c) 3rd Wave. Is to consist of the remaining aircraft and is to form an airborne reserve under the control of Group H.Q. They are to take the Southern route to the target but their time of take-off is to be such that they may be recalled before crossing the enemy coast if the 1st and 2nd waves have breached all the targets.

Recall will probably not be possible unless the first section of the 1st Wave are at POSITION 51°51' N., 03°00'E. by Civil Twilight (EVENING) + 30 minutes and the 3rd Wave must be at this position 2 hours 30 minutes later. Orders will be passed to aircraft on the Special Group frequency if possible before they reach the enemy coast instructing them which target they are to attack. Failing receipt of this message aircraft are to proceed to X, Y and finally last resort targets in that order, attacking any which are not breached. Officer Commanding, R.A.F. Station, Scampton, is to arrange for individual aircraft to be detailed to specific last resort targets.

Detailed Plan.

11. The 1st Wave is to take off in three sections each of three aircraft and fly to the target at low level by the route given in Appendix 'A'. Sections are to be spaced at intervals of ten minutes and are to fly in open formation. Height is not to exceed 1,500 feet over England. On leaving the English Coast aircraft are to descend to low level and set their altimeters to 60 feet using the Spotlight Altimeters for calibration. The QFF at various stages of the route is to be carefully noted. Aircraft are to remain at low level for the flight to the target and on the return journey at least until crossing a point 03°00'E.

12. An accurate landfall on the enemy coast is important but on no account should aircraft turn back if their landfall is not quite accurate. The routes selected should be free of all major opposition from flak but good map reading and crew co-operation is essential to keep aircraft on track. The enemy coast is to be crossed

/as low as possible

as low as possible both going in and coming out even if it is necessary to climb a little later for map reading.

13. On arriving at a point 10 miles from the target the leader of each section is to climb to about 1,000 feet. On seeing this all other aircraft are to listen out on V.H.F. Each aircraft is to call the leader of the Wave on V.H.F. on arriving at the target. Spinning of the special store is to be started ten minutes before each aircraft attacks. The leader is to attack first and is then to control the attacks on TARGETS X and Y by all the other aircraft of the 1st Wave using the Signals procedure given in APPENDIX 'B'.

14. Number 2 of the leading section of the 1st Wave is to act as deputy leader for the whole of the 1st Wave during the attack on TARGET X. Should the leader fall out No. 2 of the leading section is to take over leadership, and No. 3 deputy leadership, for the attack of TARGET X. For the attack of TARGET Y Number 4 is to take over deputy leadership, or if No. 1 is absent he is to take over leadership, in which event No. 7 is to be the deputy leader. All other aircraft are to return to base after completing their attack. The first three aircraft are to return by Route 1, the second three by Route 2 and the last three aircraft of this wave by Route 3.

15. The direction of attack of TARGET X is to be at right angles to the length of the target. The general direction of attack is, therefore, to be S.E. to N.W. Aircraft are not to be diverted to TARGET Y until TARGET X has been breached. If TARGET X is breached, up to two additional aircraft may be used, at the discretion of the leader, to widen the breach in TARGET X providing at least three aircraft are diverted to attack TARGET Y.

16. Destruction of the Dam may take some time to become apparent and careful reconnaissance may be necessary to distinguish between breaching of the dam and the spilling over the top, which will follow each explosion.

17. When TARGET X is seen to be breached beyond all possible doubt the leader is to divert the remainder of the first Wave to TARGET Y by W/T and V.H.F. where similar tactics are to be used for the attack of this target. The general direction of attack of TARGET Y is to be from N.W. to S.E. If target Y is seen to be breached beyond all possible doubt all remaining aircraft of the 1st Wave are to be diverted by the leader to attack Target Z independently using the same tactics as the 2nd wave.

18. For the attacks of both Targets X and Y the special range finder is to be used, the height of attack is to be 60 feet and the ground speed 220 m.p.h.

19. The 2nd Wave is to take off and fly to Target Z at low level by the Northern Route given in Appendix 'A'. Aircraft are to cross the enemy coast in close concentration, but not in formation, at the same time, although at a different point, as the leading section of the 1st Wave. Aircraft of this ^{Wave} will be controlled on the alternative V.H.F. channel. The special stores are not to be spun for the attack of Target Z. Aircraft are to attack this target from N.W. to S.E. parallel to the length of the dam and are to aim to hit the water just short of the centre point of the dam about 15 to 20 feet out from the edge of the water. Attacks are to be made from the lowest practicable height at a speed of 180 m.p.h. I.A.S. Aircraft are to return to base independently. First two aircraft by Route 1; second two aircraft by Route 2 and the last by Route 3.

20. The 3rd Wave is to consist of the remaining aircraft and is to form an airborne reserve under the control of Group Headquarters. They are to fly to Target X in close concentration, but not in formation, at low level by the Southern route given in Appendix 'A'. These aircraft are to be at Position 51°52'N., 03°00'E. 2 hours 30 minutes after the leading section of the 1st Wave have crossed this point on their outward route to the target. Orders for the 3rd Wave will be passed to all aircraft on the special Group frequency, if possible before they reach the enemy coast, instructing them which target they are to attack. Failing receipt of this message aircraft are to proceed to X, Y and, finally, last resort targets in that order attacking any which are not breached. The 3rd Wave are to use tactics of attack

/similar to those ...

similar to those used by the 1st Wave when attacking Targets X and Y except that attacks on last resort targets are to be made independantly. After attacking, aircraft are to return to base independantly at low level by any of the three return routes given in Appendix 'A'. Aircraft attacking early should take Route 1; the next aircraft Route 2 and the last Route 3.

Method of Attack.

21. Aircraft are to use the method of attack already practised. The pilot being responsible for line, the Navigator for height, the Air Bomber for range and the Flight Engineer for speed.
22. The interval between attacking aircraft is to be not less than three minutes on all targets.
23. On all targets except Target Z each aircraft is to fire a red veroy cartridge immediately over the dam during the attack. Aircraft attacking Target Z are each to fire a red veroy cartridge as they release their special store.
24. All aircraft are to fly left hand circuits in each target area keeping as low as possible when waiting their turn to attack.

Time of Attack.

25. The time of attack of each target by each wave is not important to within a few minutes. The time of crossing the enemy coast is, however, all important. ZERO HOUR, which will be given in the executive order, is, therefore, to be the time at which the first section of the 1st wave are to be at POSITION 51°52'N., 03°00'E. on the outward route to the target. This time will probably be Civil Twilight (EVENING) ± 30 minutes. At this time aircraft of the 2nd Wave should be about Position 53°19'N., 04°00'E.

Routes.

26. As in Appendix 'A'.

Diversions.

27. The whole essence of this operation is surprise, and to avoid bringing enemy defences to an unnecessary degree of alertness, diversionary attacks must be carefully timed. H.Q.B.C. will be asked to arrange the maximum possible diversionary attacks so that the first enemy R.D.F. or other warning of the diversionary attacks occurs 20 minutes after the leading section of the 1st wave crosses the enemy coast. No diversionary attacks should be despatched which would cross the enemy coast for a period of one hour preceding the 3rd wave. 15 minutes after the 3rd wave cross the enemy coast further diversionary attacks should be made at maximum strength and should continue, if possible until the 3rd wave are clear of enemy territory on the return journey. Diversionary attacks below 2,000 ft. should not be made in the area bounded by the points (51°00'N., 05°20'E.), (51°20'N., 06°30'E.), (51°00'N., 10°00'E.), (52°00'N., 09°00'E.), (53°20'N., 06°00'E.). H.Q.B.C. will also be asked to arrange suitable weather reconnaissance to report in particular on the visibility in the target area at least in sufficient time to recall the Lancasters before they cross the enemy coast if the weather is unsuitable.

Armament.

28. (a) Bomb Load. - Each Lancaster is to carry one special modified store (UPKEEP)
- (b) Ammunition. - All guns to be loaded with 100% night tracer (G VI).

Fuel.

29. The Lancasters may take off at a maximum all up weight of 63,000 lbs. at +14 boost. As the modified store now weighs about 9,000 lbs. 1,750 gallons of petrol can be carried.

/Navigation ...

Navigation.

30. H.Q.B.C. are requested to arrange for the Eastern Chain, Stud 5 to be switched on at Z - 20 minutes and to remain on for the whole of the operation. This should assist in making an accurate landfall on the enemy coast at the correct time.
31. The route is to be carefully studied before flight and the outstanding features, obstructions and pinpoints noted, particularly water pinpoints. E.T.A.'s at each are to be carefully calculated and if any pinpoint is not found on E.T.A. a search is to be made before proceeding to the next pinpoint. Aircraft may climb to 500 feet shortly before reaching each pinpoint if necessary to help map reading.
32. The maximum use is to be made of the Air Position Indicators.

Synchronisation of Watches.

33. All watches are to be synchronised with B.B.C. time before take off on the day of the operation.

Secrecy.

34. Secrecy is VITAL. Knowledge of this operation is to be confined to the Station Commander, C.O. 617 Squadron and his two Flight Commanders until receipt of the EXECUTIVE signal. After crews are briefed they are to be impressed with the need for the utmost secrecy because of the possibility that the operation may be postponed. The should weather reconnaissance prove the weather to be unsuitable. Otherwise, the operation is to be cancelled.

Reports.

35. Each aircraft as soon as possible after it has attacked is to report by W/T on the normal Group operational frequency in accordance with APPENDIX 'B'.

Special Devices.

36. HANDBEL and TINSER are not fitted.
37. IFF is NOT to be used on the outward journey but normal procedure is to be followed on the homeward flight. Any aircraft returning early is NOT to use IFF except after Z + 30 minutes for the 1st and 2nd Waves and after Z + 3 hours for the 3rd Wave.
38. Nickels are not to be dropped.

INTERCOMMUNICATION.

Wireless Silence.

39. Strict W/T and R/T silence is to be maintained until after Z + 30 minutes for the 1st and 2nd Waves and after Z + 3 hours for the 3rd Wave. Any aircraft returning early is NOT to break W/T or R/T silence and is NOT to identify on MF/DF except after Z + 30 minutes for the 1st and 2nd Waves and after Z + 3 hours for the 3rd Wave. Aircraft returning before that time are to cross the English Coast at 1,500 feet at the point of exit and proceed direct to base or the nearest suitable airfield. Otherwise normal operational signals procedure is to be used except as modified by Appendix 'B'.

MF/DF Section.

40. Section D is to be used if required in accordance with Paragraph 39.

Executive Order.

41. The executive order for the operation will be given by EXECUTIVE followed

/by the code word ...

by the code word allotted, the date on which the operation is to take place and the time of Zero Hour in British Double Summer Time.

42. ACKNOWLEDGE BY TELEPRINTER.

Ref:- 5G/101/54/Air.
Date:- 16th May, 1943.

M. Sattely G/C.
Senior Air Staff Officer,
No. 5 Group,
Royal Air Force.

DISTRIBUTION.

External.

Group Captain J. N. H. Whitworth, DSO., DFC.
Headquarters, Bomber Command.
(Deputy C.-in-C. personally, or in his absence,
Group Captain N. W. D. Marwood-Elton, D.F.C.).

Copy No.

1 and 2.
3, 4 and 5.

Internal.

Action Copy (Ops. II).

C.S.C.

File.

Spares.

6	} Not to be issued until after despatch of Executive Signal.
7	
8	
9, 10, 11, and 12.	

LAST 48 HOURS 15–16 MAY 1943

With the go-ahead given, the squadron had a matter of hours to prepare for the raid on the Ruhr

At 09:00 on 15 May, the Air Ministry signalled Bomber Command: "Op. CHASTISE ... Execute at first suitable opportunity." Photo reconnaissance soon confirmed no unusual activity at the dams, so after lunch Air Vice-Marshal Cochrane left No. 5 Group headquarters to inform Whitworth and Gibson that the Dams Raid would take place the following day, Sunday 16 May.

As Cochrane departed for the return journey that afternoon, Wallis arrived at Scampton and briefly conferred with Gibson before the Officer Commanding 617 Squadron followed Cochrane to Grantham to discuss operational

details. The draft version of the Operation Order included the anticipated seven dams, but the final one agreed at this conference omitted the Henne. So six target dams were listed: the Möhne, Sorpe, Ennepe and Lister (Ruhr); and the Eder and Diemel (Weser valley).

During Saturday 15 May, several 617 Lancasters were taken up on flight tests, while a special apparatus loaded others with Upkeep. That evening, on his return from Grantham, and armed with the new version of the Operation Order, Gibson briefed his two flight commanders, deputy leader at the Möhne (Flight Lieutenant Hopgood), and the Squadron bombing and navigation leaders; this was a meeting also attended by Wallis. An important

route change, not shown in the official version of Operation Order B.976, was agreed at this meeting. Hopgood mentioned a dangerous flak concentration at Hülse, and the inward route to the Möhne was moved north in order to avoid this. As the meeting broke up, Gibson was given the distressing news that his dog had been killed outside the gates that afternoon.

Early on the Sunday morning, Gibson briefed his adjutant Humphries who disguised the operational line-up as a Night Flying Programme and surreptitiously arranged for flying rations of chocolate and fruit to be put in the Lancasters. The remaining aircraft, not loaded on Saturday, had Upkeep fitted. Three hydrostatic pistols within it were set to explode



AIR VICE-MARSHAL THE HON R.A. COCHRANE (1895–1977)

Ralph Alexander Cochrane, son of a Scottish baron, graduated from the Royal Naval College, Dartmouth, and joined the airship branch of the Royal Naval Air Service. As a sub-lieutenant, he met Barnes Wallis at Vickers, Barrow, in 1916, and subsequently qualified as an airship pilot before gaining a permanent commission in the RAF. In 1920, in Cairo, he encountered Sir Hugh Trenchard, Chief of the Air Staff (CAS), who advised him "the future is in aeroplanes, young man". Cochrane served as Squadron Leader A.T. Harris's flight commander in Mesopotamia during Imperial Policing and subsequently commanded 8 Squadron. In April 1937, as a group captain he was appointed first Chief of Staff to the Royal New Zealand Air Force.

Returning to Britain, after spells at the Air Ministry, as an air vice-marshal he joined Bomber Command and took charge of 3 Group in September 1942, moving to 5 Group in February 1943. Within a month, he had been tasked by Air Chief Marshal Harris to raise a squadron for the Dams Raid and supervise its training. He was subsequently associated with Wallis's development of Tallboy and its use by 5 Group to sink the German battleship Tirpitz at Tromsø in Norway. Knighted with the KBE in January 1945, Cochrane retired as an air chief marshal in October 1952. Harris wrote that, "he would have made an outstanding Chief of the Air Staff and in my opinion an incomparable chief of the defence staff."



GROUP CAPTAIN J.N.H. WHITWORTH (1912-74)

John Nicholas Haworth Whitworth, known as "Charles", lost his father in action during the First World War. After Oundle School, he attended RAF Cranwell and was subsequently attached to the Oxford University Air Squadron, where he taught Leonard Cheshire to fly. Early in the Second World War, he flew Whitleys and Halifaxes, before commanding successively 78 and 35 Squadrons, gaining a DFC & Bar and DSO. In March 1943, he was station commander of RAF Scampton, when Squadron X (617 Squadron) formed there. Whitworth was present when Air Vice-Marshal Cochrane asked Gibson to do one more "no ordinary sortie", and it was

to him that Gibson made regular reports on the progress of his squadron's training. With Air Chief Marshal Harris and Air Vice-Marshal Cochrane, he greeted Flight Sergeant Townsend's crew, the last one to return safely. "At the shock of seeing them, I nearly fell over in shaking their hands," the wireless operator Flight Sergeant G.A. Chalmers recalled. Whitworth accompanied the King when he inspected Operation Chastise survivors at Scampton on 27 May, and received a Commendation for Meritorious Service for his work connected with the raid. Among his post-war appointments was Air Chief of Staff to the Ghana Air Force. He retired as air commodore.



30 feet (nine metres) below the surface of the water, while a fourth self-destruct pistol would detonate 90 seconds after release should the other three fail to work. Activity in the workshops, the loading of live ammunition and the swinging of compasses with Upkeep on board, all made it difficult to conceal that the operation was imminent.

Shortly before noon, specialist briefings began for wireless operators, pilots, navigators and bomb-aimers, enhanced by models of the Möhne and Sorpe dams, copious photos and maps. They finished at tea time, but other crew members (flight engineers and gunners)

remained unaware of the targets: tight security persisted.

Meanwhile, a worrying development occurred. The Lancaster damaged by Munro at Reculver had been repaired, but that by Maudslay could not be fixed; 19 aircraft were available for 19 crews with no reserve in case of emergency. So, during the afternoon of 16 May, one of the trial Lancasters was brought up from Boscombe Down at short notice; fortunately, for otherwise only 18 Lancasters would have flown that night.

In the late afternoon the final briefing for all crew members was given by Gibson – he

emphasised that they were to attack "the great dams of Germany". Wallis then explained how Upkeep had been developed and the damage that it was intended to do to German industry, especially steel production, and Cochrane concluded by prophesying that the operation would be "historic".

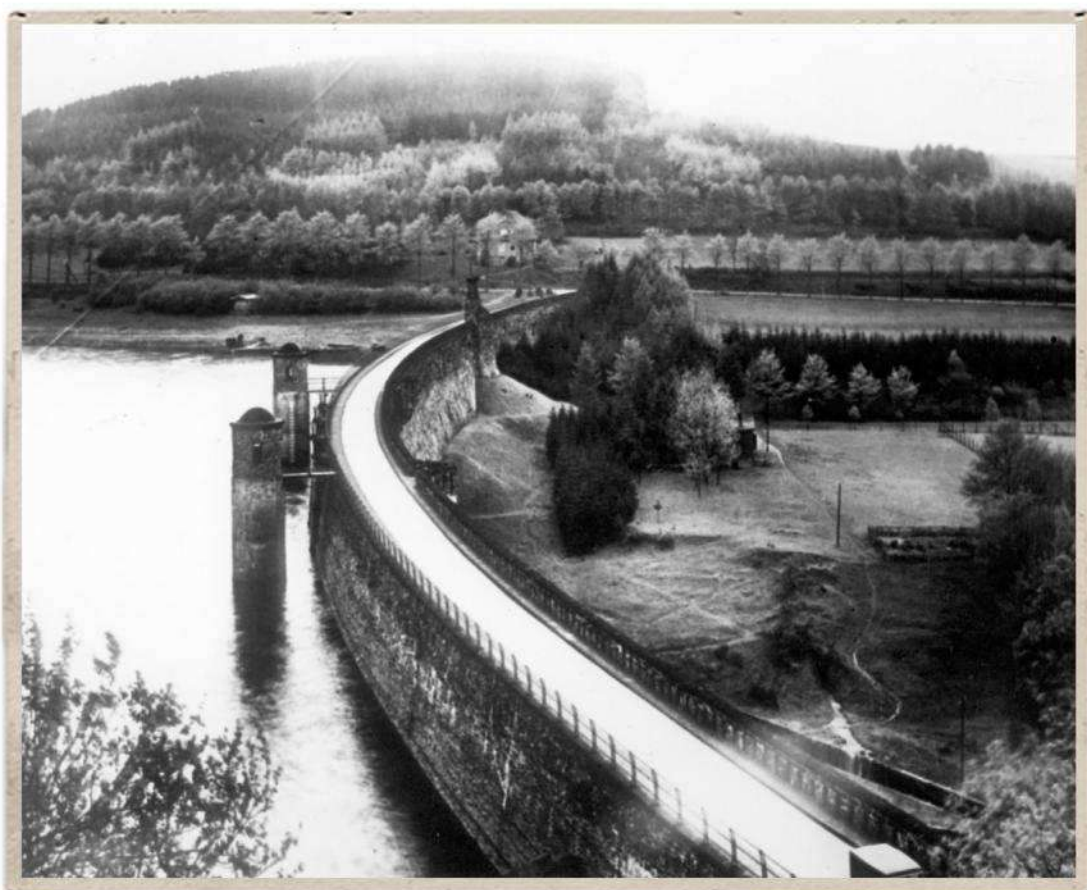
Afterwards, crews had their evening meal, went to their rooms and around 8.00pm began to converge on the flight offices to collect their flying equipment.

They then waited outside in the evening sunshine for transport to take them to their aircraft to begin the operation.

"CREWS HAD THEIR EVENING MEAL, WENT TO THEIR ROOMS AND AROUND 8.00PM BEGAN TO CONVERGE ON THE FLIGHT OFFICES TO COLLECT THEIR FLYING EQUIPMENT. THEY THEN WAITED OUTSIDE IN THE EVENING SUNSHINE"

Right: The Henne Dam had the smallest reservoir capacity on the draft list of targets, and was omitted on the night possibly due to 19, not 20, aircraft being available

Opposite: A Lancaster modified for the Dambusters Raid. The belt used for revolving Upkeep is visible under the starboard wing. The top compartment in the nose was occupied by the front gunner, the lower by the bomb-aimer



PLAN OF ATTACK

How did the revised Operation Order change the initial plans?

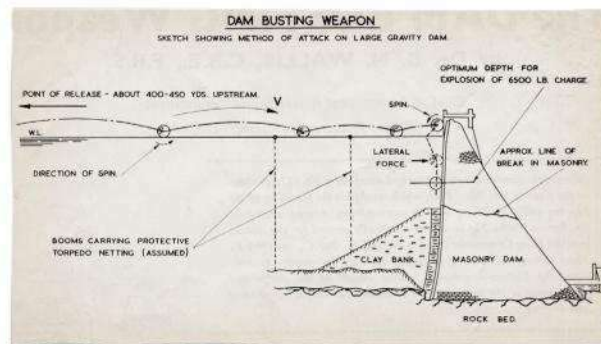
The Operation Order explained that the industrial Ruhr relied “to a very large extent” on water from massive reservoirs and that “destruction of TARGET X [Möhne Dam] alone would bring about a serious shortage of water for drinking purposes and industrial supplies”. “Next in importance” was “TARGET Z [Sorpe]”. To the east of the Ruhr, “in the Weser District the destruction of TARGET Y [Eder] would seriously hamper transport in the Mittelland Canal and in the Weser [river]”. Successful attacks on “TARGET D [Lister]” and “TARGET E [Ennepe]” would increase the impact of breaching the Möhne and Sorpe dams, “TARGET F [Diemel]” if the Eder were broken. “Twenty Special Lancasters” – 19, in reality – would be divided into three waves. The First Wave, led by Gibson, would comprise nine aircraft in three sections of three set to follow “the Southern route”. These aircraft would head out over The Wash, Southwold and the North Sea to make landfall in the Scheldt estuary. Crossing the Netherlands between the fighter airfields of Gilze Rijen and Eindhoven, they would reach the Rhine near Rees, fly eastwards to a lake close to Duellmen and Ahlen, north-east of Hamm, before turning south on the final leg west of Soest to the Möhne. Once the Möhne had been destroyed, Lancasters still with Upkeep would proceed to the Eder and, should any Upkeeps remain after that dam were breached, go on to the Sorpe. At each dam, Gibson would direct individual aircraft to attack.

The Second Wave would comprise five aircraft taking off singly to fly “the Northern Route” and cross Vlieland in the Frisian Islands off the Dutch coast, then fly south-east over the IJsselmeer (Zuider Zee) to meet the Southern Route at Rees. Thereafter, the aircraft would fly in the wake of Gibson’s wave via the Möhne to the Sorpe dam.

The Third Wave (in the Operation Order six aircraft, reduced to five on the night)

would also fly individually along the Southern Route, but would not take off until approximately two hours after the first two waves. These Lancasters, designated “an airborne reserve”, would be directed to their target while en route by a wireless message from 5 Group. They had to be prepared to attack any of the six dams, depending on the success of preceding aircraft. Attacks on all dams except the Sorpe would be made at right angles. The Lancasters were to dive at a pre-arranged spot to attain 220mph (354kph) groundspeed, a height of 60 feet (18 metres), spin Upkeep at 500rpm and release it between 425 and 475 yards (390 to 435 metres) from the target.

At the Sorpe, an entirely different method of attack was planned. There, crews would fly along the top of the dam at an indicated air speed of 180mph (290kph) and “the lowest



practicable height” to release Upkeep unspun into the water just short of the mid-point of the dam. Wallis had calculated that if Upkeep hit the dam’s sloping support 41 feet (12.5 metres) from the central core, it would roll down to detonate 30 feet (nine metres) below the surface. The explosive effect would then



GROUP CAPTAIN H.V. SATTERLY (1907-82)

A former RAF Halton apprentice, later commissioned as a pilot, Harold Vivian Satterly gained a DFC with 83 Squadron in the Second World War before becoming Senior Air Staff Officer (SASO) at Headquarters No. 5 Group. On 27 March 1943, he issued Gibson with “most secret” written orders, which forecast that the operation would require “low-level navigation over enemy territory in moonlight with a final approach to the target at 100 feet (30 metres) at a precise speed, which will be about 240mph (262kph)”.

In training, “it will be convenient to practise over water,” and be able to drop a “mine” within 40 yards (37 metres) of a specified point. Six weeks later, Group Captain Satterly drew up the Operation Order for the attack itself in “my own fair hand”. On 10 May, he sent the draft to Group Captain Whitworth, station commander at Scampton, and asked him to discuss it with Gibson. Taking into consideration some, but not all, of

their suggested changes, Satterly finalised the Operation Order, which was discussed at the 5 Group conference chaired by Air Vice-Marshal Cochrane and attended by Gibson during the early evening of 15 May. It was typed and distributed the following morning.

Satterly’s contribution to Operation Chastise was recognised with a Commendation for Meritorious Service. He eventually retired in 1959 as an air vice-marshal.





be transmitted laterally to crack the upright concrete centre. At all targets, except the Sorpe where this would occur on release of Upkeep, a red Very cartridge would be fired as an aircraft crossed the dam after dropping its weapon. This would allow estimation of the time for the next attack once the water settled.

Three exit routes were laid down, planned to avoid known flak concentrations, all crossing the Helder peninsula abutting the North Sea. A maximum 500 feet (150 metres) was to be flown until the English coast, the enemy coast being crossed "at the lowest possible height".

Opposite-top-right: The method of attack: a slightly inaccurate demonstration of Upkeep's behaviour as the bounces were not even in height. The first rose to 30 feet (nine metres), the final to 4 feet (one metre). The explosive charge was 6,600lbs (2,993kg)

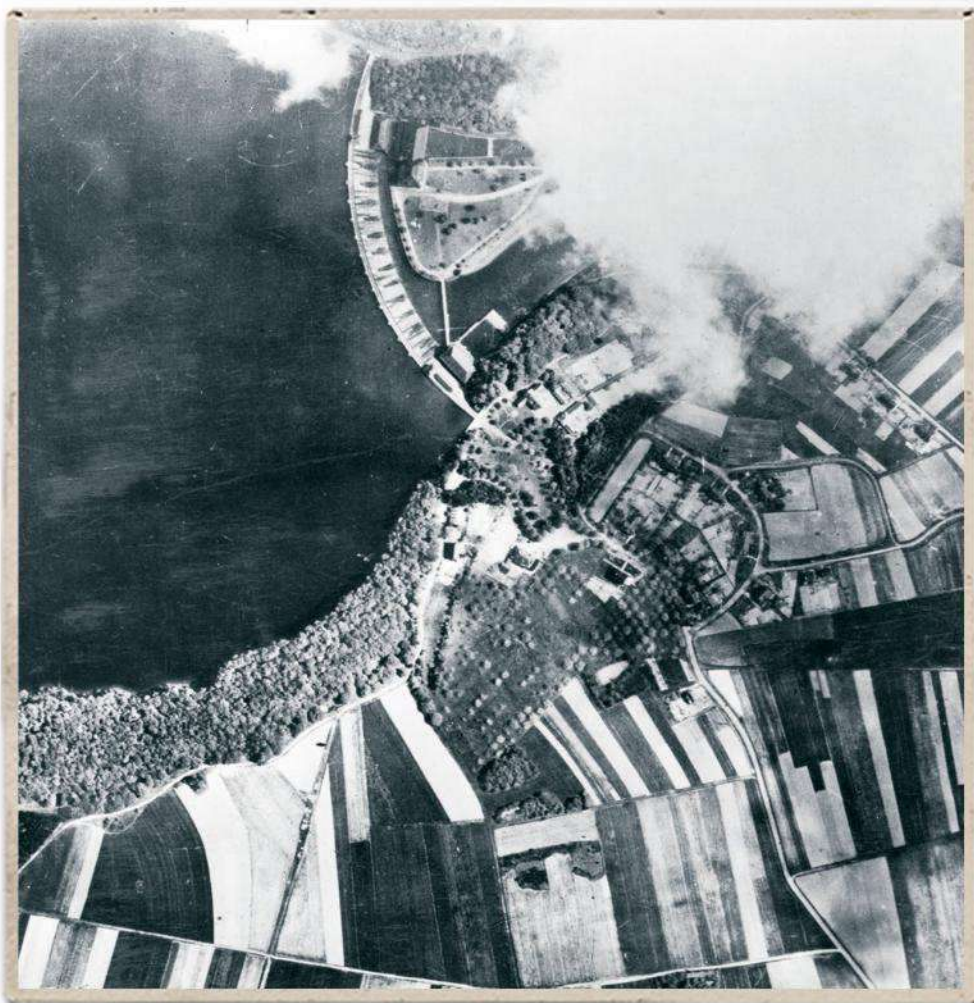
Opposite-bottom-left: The Möhne Dam briefing model constructed at Phyllis Court Henley, part of RAF Medmenham. The aircraft flew left to right along the lower sleeve of water. The dam can be seen bottom right

Opposite-centre: An RAF reconnaissance photo of the Eder Dam, 13 May 1943. It was used at the pre-operational briefing, because the model was not completed until after the raid

Bottom-right: Upkeep in position on Wing Commander Guy Gibson's Lancaster AJ-G. Note how far the weapon hangs beneath the fuselage between the calliper arms. See, too, the prominent belt used to rotate it

Right: RAF reconnaissance photo of the Eder Dam, 13 May 1943. Mist obscures the steep hill (top right) over which Lancasters attacking left to right had to climb

Above: A modified Lancaster airborne during pre-operational tests at Boscombe Down. Note the patch where the mid-upper turret was removed and that the calliper arms have not yet been fitted



UPKEEP IN POSITION

AJ-G, Guy Gibson's Lancaster (pictured), shows Upkeep held between two V-shaped calliper arms welded to the fuselage and the absence of bomb-bay doors. The three hydrostatic pistols, preliminarily armed by removal of three horseshoe washers before take-off and fully armed in the air by the bomb-aimer, together with the self-destructive pistol which would be activated as it left the aircraft, were inserted in the starboard side of Upkeep. The belt running round a protrusion from the weapon and a wheel-like device connected to a motor mounted on the floor of the fuselage rotated Upkeep at 500rpm. The blister in the perspex on the starboard side

of the cockpit, through which the navigator would peer to ensure the Aldis lamps were forming a figure of eight forward of the leading edge of the wing, can be seen above the wing.

The navigator would stand in the sunken walkway leading to the bomb-aimer's department, with the flight engineer in front of him, the pilot in his seat above left and the wireless operator attending to the gauge (which controlled the speed of Upkeep's rotation), crouching on the floor behind him. The front gunner, above the bomb-aimer in the forward compartment, had his legs in stirrups to avoid disturbing his colleague.



TAKE OFF

16 MAY 1943

Under the guise of another exercise, the crew took flight one last time

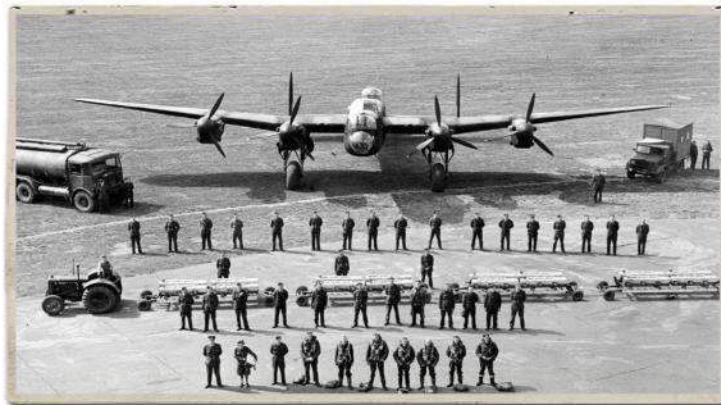
Before every operation there was tension, but before Operation Chastise the strain was extraordinary. After the final briefing, one crew member sought out the padre Reverend C.D. Hulbert, for his blessing. Flight Sergeant Townsend feared "we were all for the chop", which Sergeant Tees decided that if he were going to die, he would do so clean and went for a bath. Flight Lieutenant Hopgood predicted that he would not survive, while his navigator guessed that eight aircraft would not return.

At 20:15, crews of the first two waves piled into buses and trucks to be ferried to their Lancasters, where many saw Upkeep for the first time. As pre-flight checks were underway, groundcrew, administrative staff, Third Wave crews, senior officers and Wallis gathered to see them off.

Officially, this was simply another night exercise, but as Leading Aircraftman Munro noted, "the interaction between ground crew and aircrew was such that your sixth sense told you that this was 'it' ... a general quietness in communication".

Shortly after 21:00, Flight Lieutenant R.E.G. Hutchison DFC (Gibson's wireless operator) fired a red Very light to signal pilots to start engines and move in sequence to the perimeter track preparatory to take-off. Because they were to fly the longer northern route across the North Sea to cross the enemy coast over the Frisian Islands 120 miles (195 kilometres) from Gibson's wave, Second Wave aircraft took off first.

At 21:28, Flight Lieutenant R.N.G. Barlow DFC RAAF responded to a green signal from the control caravan and began to roll his Lancaster northwards along the runway, lift over the far fence and turn towards the North Sea.



One minute later, Flight Lieutenant J.L. Munro RNZAF followed him, then went Pilot Officer W.H.T. Ottley DFC (21:30) and Pilot Officer G. Rice (21:31). This wave should have been led by the American Flight Lieutenant J.C. McCarthy DFC RCAF, but during the pre-flight checks his Lancaster had suffered a malfunction in one engine. Frantic in case another crew should take the reserve

PREPARING FOR TAKE-OFF

Wing Commander Gibson and his crew entering their Lancaster AJ-G prior to take-off for Operation Chastise (left). After collecting their flying gear from the flight offices, crews would be transported to their aircraft. Once on board, a series of pre-flight tests were undertaken and only on satisfactory completion of these would the pilot switch off the engines and await the signal to take-off. It was during the pre-flight tests that Flight Lieutenant McCarthy discovered that AJ-Q had an engine problem and, therefore, had to fly to the Sorpe Dam in the reserve aircraft AJ-T. Shortly after 21:00, Gibson's wireless operator fired a red Very light, the signal for all First and Second wave Lancasters to start up and move in a predetermined order from their hard stands round the perimeter track to the end of the runway. There, on a green signal from the control caravan, the pilot would commence the run northwards over the grass with his laden aircraft. Several crew members were concerned about whether the Aldis lamps would be misaligned as their aircraft bumped along and more than one pilot maintained that he crawled through, rather than over, the perimeter hedge that night. Gibson led his three Lancasters away at 21:39 after the four Second Wave aircraft, which had already taken off singly.



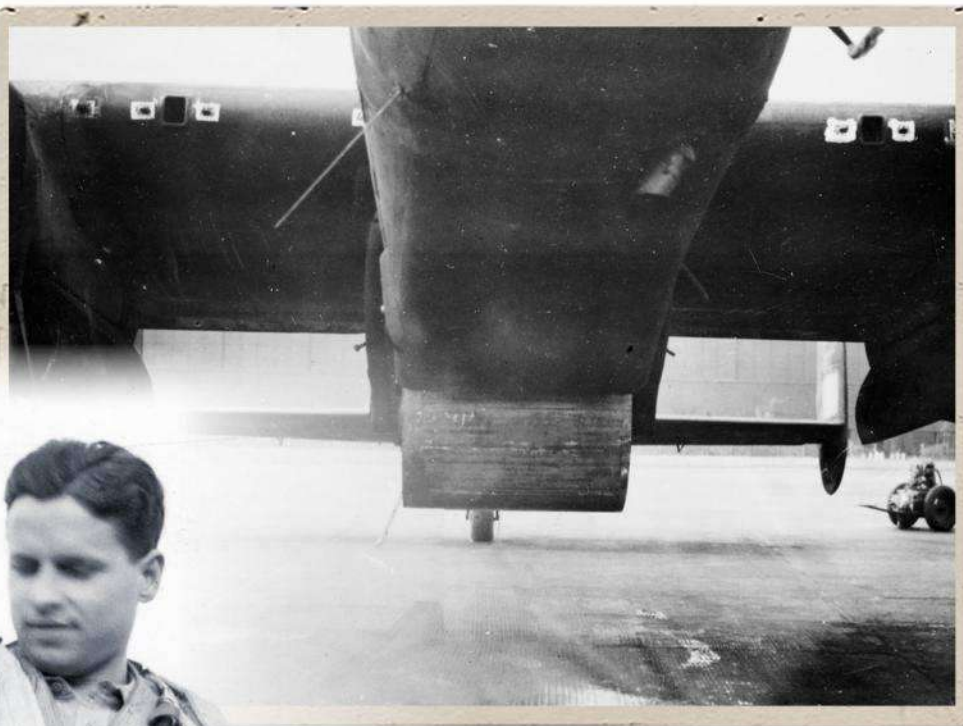
"IT WAS DURING THE PRE-FLIGHT TESTS THAT FLIGHT LIEUTENANT MCCARTHY DISCOVERED THAT AJ-Q HAD AN ENGINE PROBLEM AND HAD TO FLY TO THE SORPE DAM IN THE RESERVE AIRCRAFT"

aircraft, which had only arrived at 15:30 from Boscombe Down, McCarthy's crew scrambled into transport to claim it. Upkeep, hanging beneath the fuselage, affected the compass, so two magnetic readings were required: with Upkeep (for the outward journey) and without for the return flight. One card was missing, so McCarthy dashed off to the flight office for a replacement. The need for further pre-flight checks and this hiatus meant that McCarthy took off at 22:01, after all the First Wave Lancasters had left, and he therefore trailed the other four aircraft of the Second Wave by 30 minutes.

Meanwhile, with Hopgood to his right and Flight Lieutenant H.B. Martin DFC to his left, at 21:39 Gibson led off the first formation of the First Wave with the evening sun still over the horizon after a sweltering day. Nine minutes later, Squadron Leader H.M. Young DFC & Bar with Flight Lieutenant D.J. Maltby DFC to his right and Flight Lieutenant DJ Shannon DFC RAAF on his left, took off. At 21:59, with Flight Lieutenant W. Astell DFC and Pilot Officer L.G. Knight RAAF to his right and left respectively, Squadron Leader H.E. Maudslay DFC led away the third and final formation of the First Wave.

As the last of these 14 Lancasters faded in the distance, Cochrane, Whitworth and Wallis prepared to drive to 5 Group headquarters to hear news of the operation as it progressed, groundcrew dispersed to await the return of the aircraft, and other staff went back to their offices or retired to mess ante-rooms. They were prepared for a long night.

For crews of the Third Wave, there was an anxious wait. Perhaps they would not be needed after all.



Opposite-top: This image shows the personnel and equipment required to get a Lancaster into action: aircrew (first row), flight maintenance staff (second), bombing-up staff with towing tractor (third), ground servicing crew (fourth). Beside aircraft, petrol bowser (left), mobile workshop and crew (right)

Top: David Maltby (now Sqn Ldr) and Guy Gibson examining post-operational photos in the OC's office above No. 2 Hangar at RAF Scampton

Left: Wg Cdr G.P. Gibson (right) and his navigator Flt Lt R.E.G. Hutchison, the only member of his crew to come with him from 106 Squadron, prior to take-off

Above: This photo was taken from the front of a Lancaster and shows Upkeep in position for the raids

FIRST WAVE 16–17 MAY

In air and with their Upkeeps at the ready, the First Wave made the initial attempts to breach their targets

Like other aircraft, Gibson's three Lancasters tested the Spotlight Altimeter Calibrator (converging Aldis lamp beams) over the North Sea before settling at 100 feet (30 metres). To avoid known and unexpected obstacles, the bomb-aimer, armed with maps illuminated by a soft lamp, kept a sharp look-out to warn the pilot and navigator of any impending danger. Above him, the front gun was manned by the gunner, who would have normally been in the mid-upper position. The more experienced rear gunner was isolated beyond the wireless operator.

Gibson made landfall to starboard of the intended spot, and was again off-track at the Rhine. Veering north towards the turning point near Rees, the three Lancasters encountered their first flak. Flying eastwards along the amended route, a searchlight concentration was encountered north-west of Dorsten and fierce flak east of Duellen, which damaged Hopgood's port wing and caused Gibson to broadcast a warning to 5 Group. More evasive action meant that Martin reached the Möhne before Hopgood and Gibson.

The second formation, led by Young, also ran into flak, but arrived together. Maudslay's three were less lucky. They became separated over the Netherlands, and as they were approaching the Rhine, Astell lagged behind the other two. East of Rees and north-west of Dorsten, where Gibson reported activity, Astell was shot down and Maudslay's aircraft damaged. Meanwhile, Gibson had flown a dummy run over the Möhne Dam, on which three 20mm flak guns were mounted. Three more were stationed in a meadow beyond, ideally placed to engage aircraft turning to port after crossing the dam.

Two rivers flowed into the reservoir, the Möhne (right) and Hever (left). The method of attack called for each Lancaster to dive over the further of two bridges (Koerbecke) across the Möhne, pick up speed and hop over a wooded spit of land before turning towards the dam. As it did so, the flight engineer took responsibility for speed, the navigator looked out of a blister in the cockpit canopy to ensure that the Aldis beams formed a figure of eight forward of the leading edge of the starboard wing, and the wireless operator spun Upkeep at 500rpm.



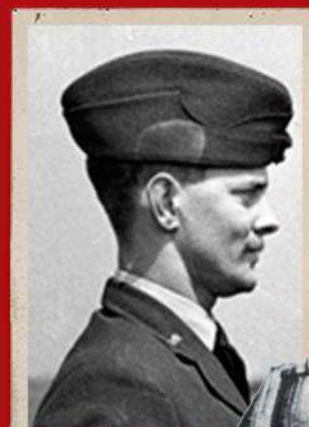
Approaching the dam a second time, Gibson dropped the first Upkeep, which exploded just short of the left-hand tower. Hopgood's aircraft, already damaged and set alight by flak, released its Upkeep late. Before crashing north of the dam, Hopgood got the stricken Lancaster high enough for three of the crew

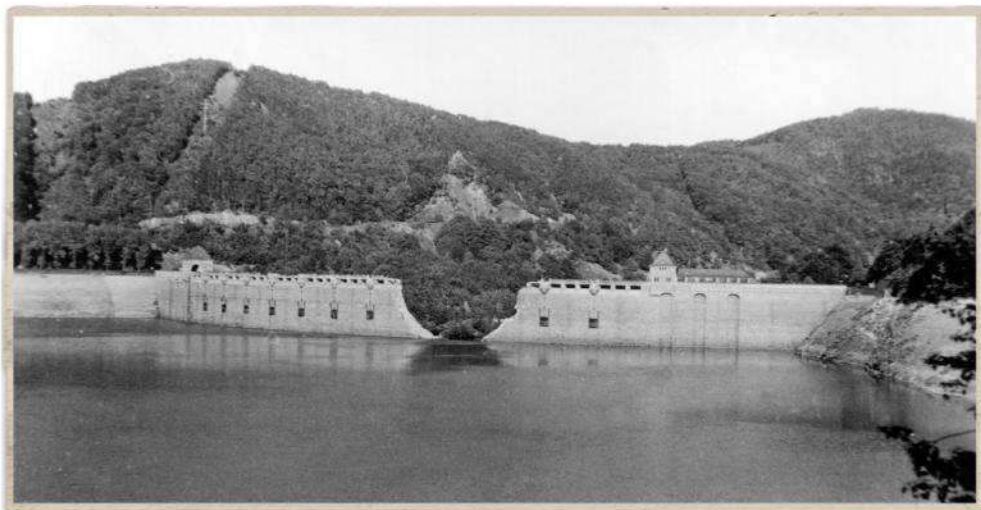
FLIGHT LIEUTENANT H. MARTIN (1918–88)

Harold Brownlow Morgan "Mick" Martin was an Australian, who in 1940 enlisted in the RAF, where he became a bomber pilot. Between October 1941 and 1942, he completed a tour and gained a reputation for low flying. He was instructing at a Heavy Conversion Unit, when Gibson rang him with an invitation "to come to the party". Martin duly gathered a crew and arrived at Scampton on 31 March 1943. During Operation Chastise, he flew in Gibson's leading formation of three and was the first to reach the Möhne Dam, because the other two had become detached. Martin released the third Upkeep, after Hopgood's aircraft was shot down. Following his attack, Martin flew in with Young and then Maltby to help them combat the defences.

Once the Möhne had been breached, he returned to Scampton. Martin stayed with 617 under Squadron Leader G Holden, and, when Holden was killed, he commanded the Squadron for three months until the arrival of Leonard Cheshire.

Martin's last (49th) bomber operation was to the Antheor Viaduct in Italy, February 1944, but he would fly 34 further operations in Mosquitoes. "The ideal wartime operational pilot," in Cheshire's view, "He had superb temperament, was quite fearless and innovative in his thinking." Martin left the RAF in 1974 as Air Marshal KCB, CB, DSO & Bar, DFC and two bars, AFC. His final appointment had been Air Member for Personnel on the Air Council.





to bale out, two of them surviving to be taken prisoner. Martin's Upkeep, the third dropped, bounced to the left and exploded on the reservoir's bank. Young now attacked and seemed to have failed, but as Maltby (the fifth aircraft) approached, he saw the dam crumbling, moved to port and made a second breach in the wall.

Maltby and Martin returned to Scampton, while Gibson, Young (as deputy leader) and the three Lancasters still with Upkeep made for the Eder. There, the attackers faced a steep dive close to the prominent Waldeck Castle, a sharp turn to port over a spit and then needed

to clear a steep hill beyond the dam after their attack before, as at the Möhne and elsewhere, circling to port.

Shannon caused damage close to the right-hand tower, Maudslay, whose Upkeep dropped late, stripped the crest of the dam and Knight, with the last remaining Upkeep, punched a great hole in the structure.

The First Wave had breached both the Möhne and Eder dams, but at a cost. Astell had been lost on the way in, Hopgood at the Möhne and Maudslay and Young on the way home. Just five of the nine who set out landed safely again at Scampton.



Bottom-left: Australian David John Shannon (1922-93) joined the RAAF in 1941 and subsequently flew 69 operations over Europe with 106 and 617 squadrons. He retired in 1945 as squadron leader

Bottom-right: Flt Lt William Astell. Originally in C Flight, 57 Squadron, before being posted to 617. His plane crashed and all crew were lost. It is suspected this happened when he fell behind after others in his formation misread a turning point

Left: The gap created in the Eder Dam by Flt Lt G. Knight's Lancaster. Note the steep hill beyond the dam which aircraft attacking from the water side had to negotiate

Bottom: This crashed Lancaster is reputedly Sqn Ldr H.M. Young's machine shot down off the Netherlands' coast on the way back from the Eder Dam

Opposite-top: A view of the breached Möhne. Water can be seen pouring through the hole, leaving the banks of the reservoir exposed. Note the white swell beyond the dam. The image was later signed by Gibson and his crew on the exposed ground at the bottom of the photo

Opposite-bottom: Note the triangular structure of the wall, the tower off which a flak gun was blown and the ornamental trees used to disguise the structure

SQUADRON LEADER H.M. YOUNG (1915-43)

Born in London, son of a British father and an American mother, Henry Melvin "Dinghy" Young spent his early years in the USA and would marry a Californian, but he was educated at Westminster School and rowed for Oxford in the 1938 boat race. After joining the RAF, he flew two bomber tours and was twice shot down over the sea, but survived in a dinghy, hence his nickname. In March 1943, already holding the DFC & Bar, he commanded C Flight No. 57 Squadron at RAF Scampton, which was posted across the station to 617 Squadron. Young became Gibson's senior flight commander and stood in when the OC was absent; he was "a fantastic administrator" according to Pilot Officer G. Rice. Young was the fourth pilot to attack the Möhne Dam. Despite "three good bounces and contact", there was no apparent success until the fifth attacker, Flight Lieutenant D.J.H. Maltby, saw the wall already crumbling and moved to port to drop his Upkeep. Young now had no Upkeep but, as Gibson's

deputy on the operation, he proceeded to the Eder Dam and was shot down flying home. After crossing the Dutch coast near Castricum aan Zee, flak gunners accounted for what they identified as a Halifax. The bodies of the crew were later washed up and buried at Bergen.



SECOND WAVE 16–17 MAY 1943

Disaster, unexpected surprises and tragedy followed the second group

After Flight Lieutenant Barlow left Scampton at 21:28 nothing was heard of his Lancaster. It later emerged that it had crashed with total loss of life near Haldern, three miles (five kilometres) east of Rees, close to where aircraft of the Second Wave were scheduled to join the Southern Route flown by Gibson's nine Lancasters.

Taking-off one minute after Barlow, Flight Lieutenant Munro crossed England and the North Sea without incident and approached the Frisian Islands. Despite flying at low-level, the Lancaster was undoubtedly then hit by flak, but the crew could not agree on its origin. The front gunner and pilot thought the fire came from land-based batteries, the bomb-aimer from a flak ship beyond the islands.

Whatever the reason, the Lancaster had clearly been severely affected, and Munro flew on over the IJsselmeer as the extent of the problem was assessed. A hole had been torn in the fuselage, the intercom system was destroyed, wireless set smashed, the master

compass unit shattered and the rear turret damaged. Sergeant Howarth, the front gunner, reflected: "We could not speak to one another – essential for calling out speed and direction in case of fighter attack. We could not speak to other planes in the wave and were left with one very unreliable compass, and had very little defence against fighters." So Munro took the inescapable decision to turn back, landing at Scampton with Upkeep still attached, the first aircraft to return from Operation Chastise.

Pilot Officer V.W. Byers left Scampton a minute after Munro and, like Barlow, nothing more was heard from him. It later emerged that his Lancaster had crashed into the Waddenzee, beyond the Frisian Islands, almost certainly shot down by flak gunners on the island of Texel.

Pilot Officer Rice flew the fourth Second Wave aircraft and suffered a bizarre accident. Having successfully crossed the Frisian Islands, he sank low over the sea after turning south-east on to the briefed track. In the

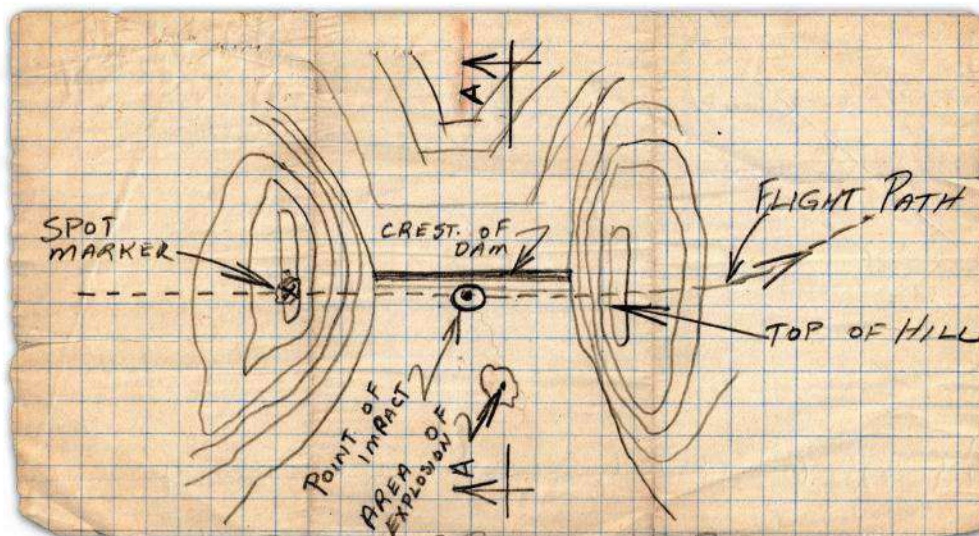


moonlight, height was difficult to judge and suddenly there came a violent crash and vibration throughout the aircraft. After pulling up over the IJsselmeer, it became obvious that Upkeep had been torn off when the Lancaster inadvertently struck the water. Like Munro,

FLIGHT LIEUTENANT J.L. MUNRO (1919–2015)

John Leslie ("Les") Munro entered the Royal New Zealand Air Force in 1941 and, after training in Canada, first flew as a bomber pilot with 97 Squadron at Woodhall Spa the following year. Having completed 22 operations, for which he was awarded the DFC, he joined 617 Squadron in March 1943 with four of his regular crew, a replacement bomb-aimer and rear gunner being recruited before arrival at Scampton. Destined to attack the Sorpe Dam during Operation Chastise, his Lancaster was badly damaged by flak and he was forced to turn back over the Netherlands. With his wireless equipment destroyed and unable to communicate, Munro almost collided with another early return as he came in to land again at Scampton. Munro remained with the Dambusters Squadron and was promoted Squadron Leader in charge of B Flight under Leonard Cheshire, when he took command. After almost two years, in July 1944 Munro was compulsorily taken off operations and assigned to a training post. Meanwhile, he had gained the DSO. Munro retired from the RNZAF in 1946, having flown 58 operations, a number which he believed himself "lucky" to have survived. Post-war, he became a farmer, entered local politics and for 17 years was mayor of Waitomo District Council. Les Munro was made a Companion of Queen's Service Order (QS) in July 1991 and a Companion of the New Zealand Order of Merit (CNZM) in June 1997.



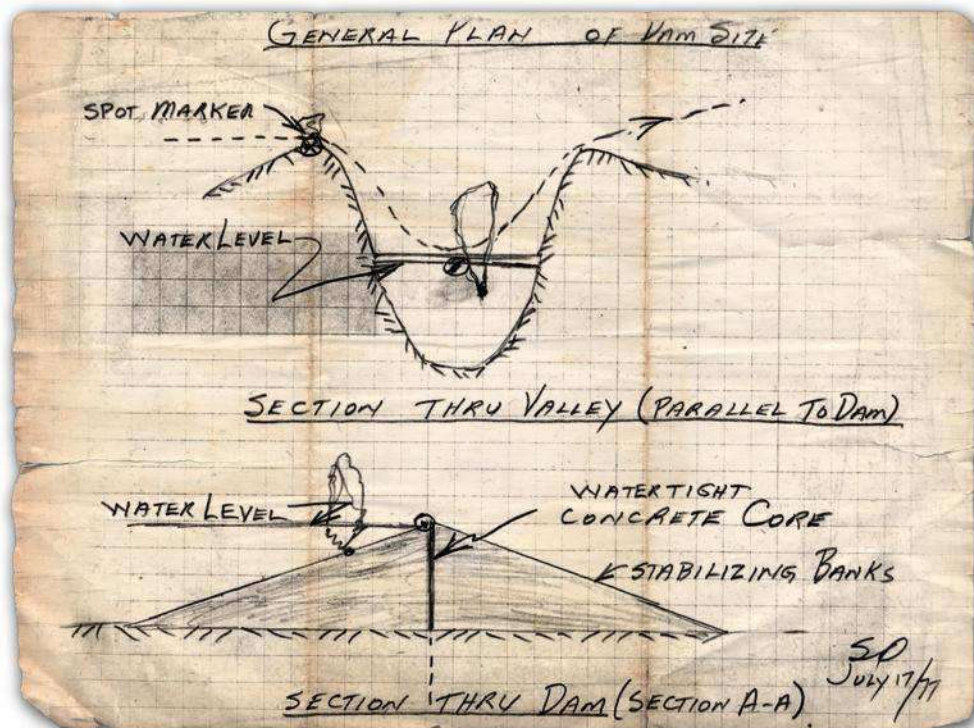


Opposite-top: An Upkeep mine, which had not detached for the self-destructive device to work, was recovered intact from the wreckage of Flt Lt Barlow's Lancaster near Rees on the Rhine

Opposite-bottom-left: An RAF reconnaissance photo of the Sørpe Dam showing damage to the crest of the dam and water washing down the air-side support from the reservoir (hidden right). The equalising basin can be seen at the centre of the image

Top-left: Another sketch by Oancia shows the point of impact in the middle of dam and the moment of detonation shown from above. Note the flight path circling to the left (port), as at all other dams

Bottom-left: Sketches of the Sørpe Dam by Canadian Sgt Steve Oancia, the bomb aimer of F/Sgt K.W. Brown's aircraft. The top sketch shows the spot marker dropped level with the crest of the dam, Lancaster's dive over the left hill, release Upkeep and climb over the far (right) hill. The bottom sketch shows Upkeep rolling down the stabilising bank on the water side to detonate 30 feet (9 metres) below the surface



“OF THE FIVE SECOND WAVE AIRCRAFT, TWO HAD BEEN SHOT DOWN, TWO RETURNED EARLY WITH SEVERE DAMAGE AND ONLY ONE ATTACKED THE SORPE”

PILOT OFFICER G. RICE (1917-81)

The son of a Royal Navy writer and born in Portsmouth, Geoff Rice grew up in Hinckley, Leicestershire, before enlisting in the RAF in 1941. He qualified as a pilot, was commissioned in February 1942 and flew a tour with Coastal Command on Whitleys. Converting to Lancasters, in February 1943, he joined 57 Squadron at Scampton and had undertaken only eight operations, when posted to 617 Squadron on 26 March 1943. Between 1 April and 14 May, Rice flew 26 training flights. Detailed to attack the Sørpe Dam, he took off at 21:31 on 16 May only to lose Upkeep when his Lancaster clipped the water at low level after crossing the Frisian Islands. Landing at Scampton again at 00:46 on 17 May, Rice felt “very depressed” at having made “a complete balls of things”. At the debriefing, Sir Arthur Harris told him “you are a very lucky young man” and next day Gibson said “bad luck, I almost did the same thing.” Rice remained with 617 Squadron to survive the disastrous attack on the Dortmund-Ems canal in September, when several Dams crew members were lost. After being promoted Flying Officer and awarded the DFC, Rice was shot down on 20 December 1943 and taken prisoner. Post-war he flew Mosquitoes in Germany and left the RAF in July 1947.

Rice had no choice but to turn back. None of the first four Lancasters destined for the Sørpe had reached the target. Only McCarthy, who belatedly took off two minutes after the last formation of Gibson's wave, could do that. En route his aircraft ran into trouble. As McCarthy remarked: “Very hot reception from natives when crossed the coastline. They knew the track we were coming in on.” Between the coast and the target, other flak concentrations opened up and, although the dam itself was clear, the vicinity of the target was swathed in mist. The Sørpe nestled between two hills. On the western one lay the village of Langscheid, and to line up along the crest of the dam, McCarthy had to wriggle round the

church spire. So difficult did this prove that Sergeant G. Johnson (the bomb-aimer) forced the pilot to fly across the dam nine times, on each occasion completing a left-hand circuit before, to a chorus of disparaging remarks, he released Upkeep accurately at the tenth attempt. As McCarthy cleared the far hill and turned to port, a vast plume of water spouted upwards, but it was impossible to decide what damage had been caused. Despite encountering heavy flak near Hamm and at the coast, McCarthy reached Scampton safely.

Of the five Second Wave aircraft, two had been shot down, two returned early with severe damage and only one had attacked the Sørpe, with unknown results.

THIRD WAVE 17 MAY 1943

Despite more success than the prior wave, the third group still suffered

The five crews of the Third Wave left Scampton shortly after midnight. Like the Second Wave, they took off singly with Pilot Officer W.H.T. Ottley's Lancaster first away at 00:09. A message to attack the Lister was acknowledged at 02:30, but two subsequent ones to divert to the Sorpe went unanswered. The aircraft's fate was later described by Sergeant Tees, the rear gunner. About 15 minutes short of the dam, he heard the wireless operator say, "Möhne gone", when searchlights coned the machine and flak began to strike it. Tees woke up on the ground; the third survivor of a lost Lancaster to become a prisoner of war that night.

Ottley crashed at Heesen, five miles (eight kilometres) north-east of Hamm, almost certainly having turned short of the designated course alteration at Ahlen. The explosion was seen by the crews of two following aircraft and by Gibson flying home.

Pilot Officer L.J. Burpee RCAF left Scampton two minutes after Ottley and his aircraft went "missing without trace". Briefed to fly beyond the Scheldt estuary between enemy airfields at Gilze Rijen and Eindhoven, German records showed that Burpee strayed over the former and perished. 5 Group's instruction to attack the Sorpe therefore went unacknowledged.

Flight Sergeant KW Brown RCAF took off at 00:12, with a stranger in the crew. His front

gunner reported sick and Sergeant D. Allatson from one of the two grounded crews took his place. Like Gibson, Brown was off-track at the enemy coast, but unlike him met extremely hostile fire almost immediately. Ordered to the Sorpe, Brown saw the breached dam while crossing the Möhne reservoir, but found the defences still very active.

At the target, the mist faced by McCarthy had thickened considerably. Like the American, Brown flew circuits to port, in his case six, before Upkeep could be released. Circling after the steep waterspout rose, "crumbling" could be seen along the top of the dam with "no apparent breach". On the way back, the Lancaster ran into dangerous flak concentrations, especially near Hamm and at the coast. On landing, the perforated, starboard side of the fuselage could clearly be seen, the top of the cockpit canopy stitched with holes.

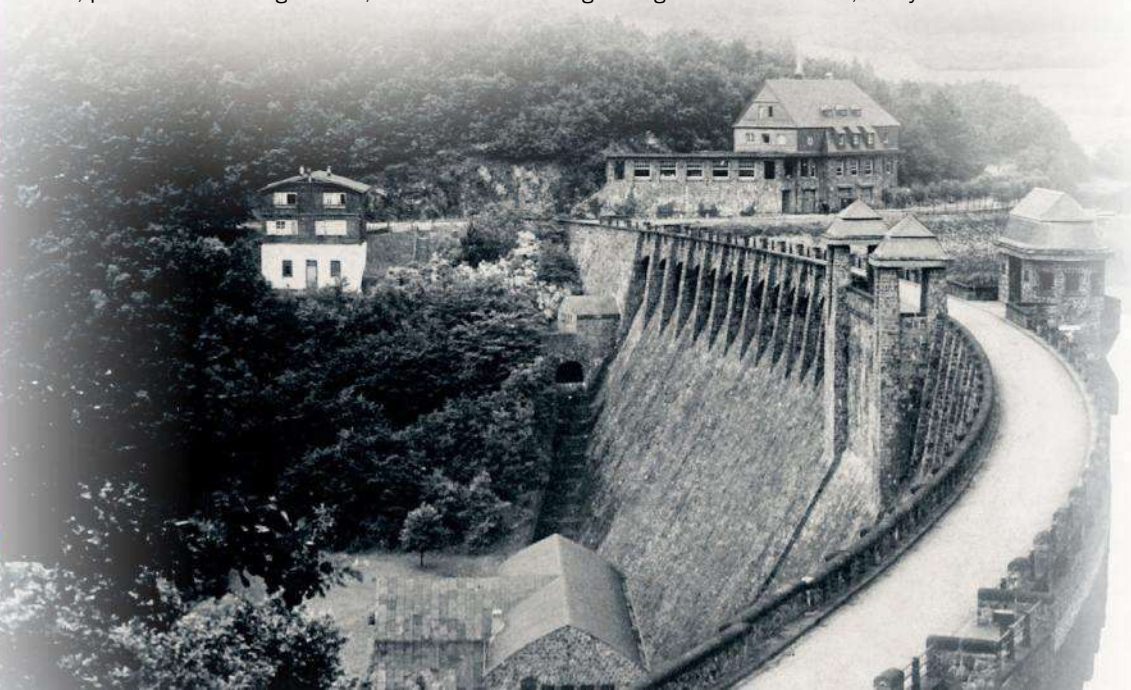
Flight Sergeant W.C. Townsend was the fourth pilot to take off, at 00:14, "on a beautiful full moon night". After crossing the Scheldt estuary, "the land below was clearly seen, peaceful with no sign of war," but

soon the flight became "very, very nasty". Like those which preceded it, the aircraft frequently encountered searchlight and flak concentrations and, at one point, Townsend flew down a fire-break in a forest to avoid enemy fire. Approaching the Möhne, the Lancaster was ordered to the Ennepe dam through rising mist and "wooded, valley-marked



SERGEANT F. TEES (1922-83)

Fred Tees was an apprentice hairdresser when he joined the RAF to become an air gunner. In March 1943, he was flying in 207 Squadron with Pilot Officer Ottley, who heard that Gibson was forming a new squadron and "wangled" a posting to Scampton. Ottley's crew took their Lancaster with them, and the five NCOs shared an empty married quarter there. His aircraft, AJ-C, was the first of the Third Wave to take off at 00:09 on 17 May. AJ-C encountered occasional searchlights and pockets of flak at which Tees, in the rear turret, "fired away". The Lancaster flew so low that, at one point, he looked up as it passed below a church steeple. When the Lancaster was shot down near Hamm at 02:35, Tees was the only survivor because his turret was blown off. He woke up on the ground with severe burns, and after hospital treatment spent the rest of the war in captivity. In December 1944, he overcame meningitis and, like many other PoWs, was subjected to forced marches as the Allies advanced from west and east. During the first week of May 1945, he reached his home in Chichester, to discover that his widowed mother had died when a bomber crashed on the laundry where she worked.



country with little or no features to map read". Townsend's crew reported dropping Upkeep just short of their target, with "contact believed as ripples seen against the dam."

Flying back via the Möhne, the navigator observed a "sheet of water about 7 miles long and extending 4 miles wide up valley, with (breached) dam in middle." The flight home proved equally "nasty", particularly at the coast, but Townsend landed his aircraft at 06:15 in broad daylight, the last Chastise Lancaster to return.

The final Third Wave aircraft, piloted by Flight Sergeant C.T. Anderson, had taken off at 00:15, but was damaged and forced off track near Duelsen, having initially been ordered

to the Lister, then the Sorpe. With dawn fast approaching and little prospect of reaching any target in the misty conditions, Anderson returned along the entry route via the Scheldt.

So, of the five Third Wave aircraft, one had returned early, two had been shot down, and two reported attacking their targets.

Opposite-left: This pre-operation reconnaissance photo shows part of the winding approach to the Lister reservoir and dam, which are near Eichen (off-shot right)

Opposite-bottom: The Lister Dam, 30 miles (48 kilometres) south of Möhne, its reservoir capacity was 22 million cubic metres. Curiously, the British thought there were two towers 886 feet (271 metres) apart; actually there was only one

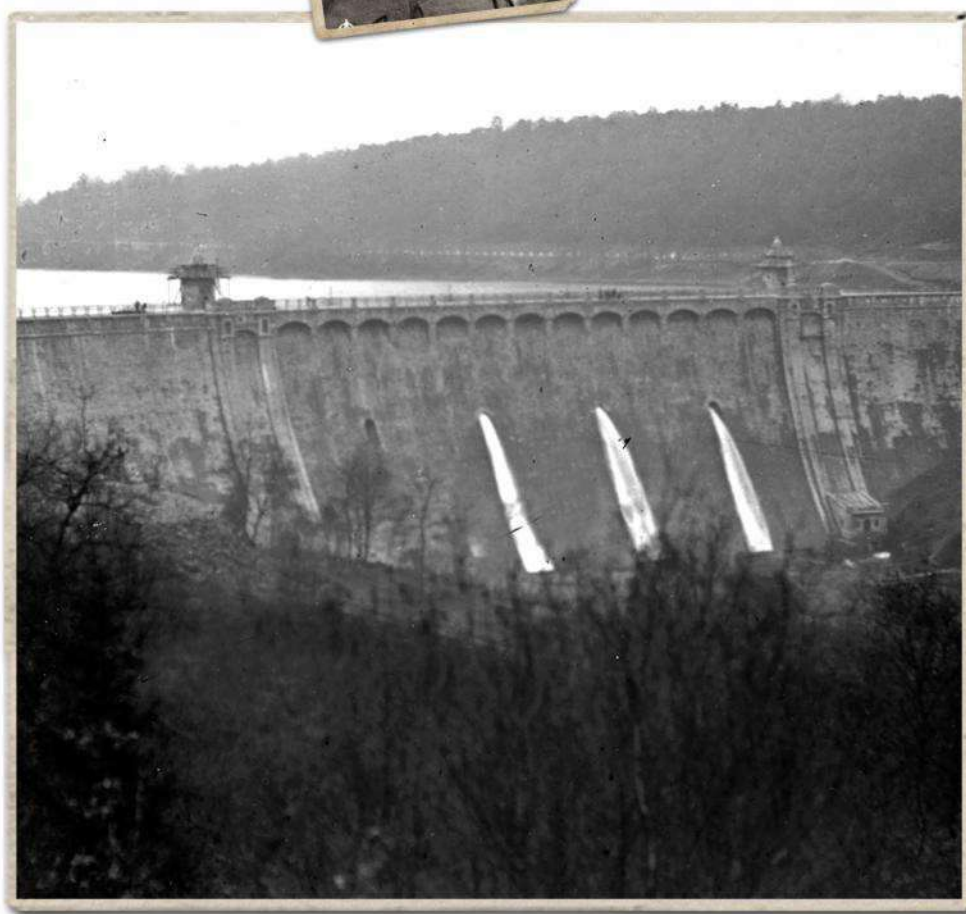
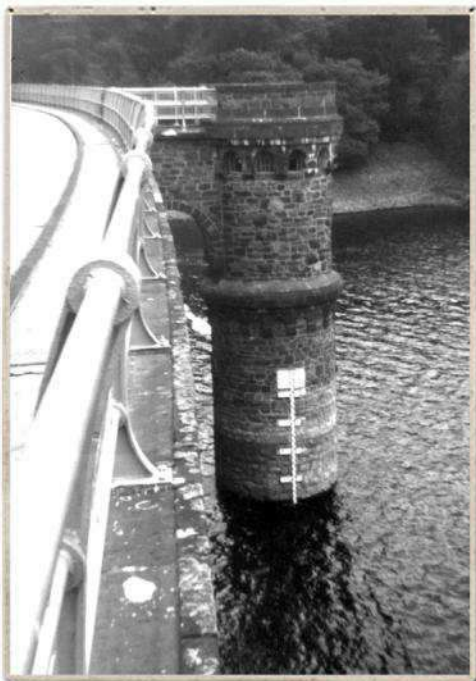
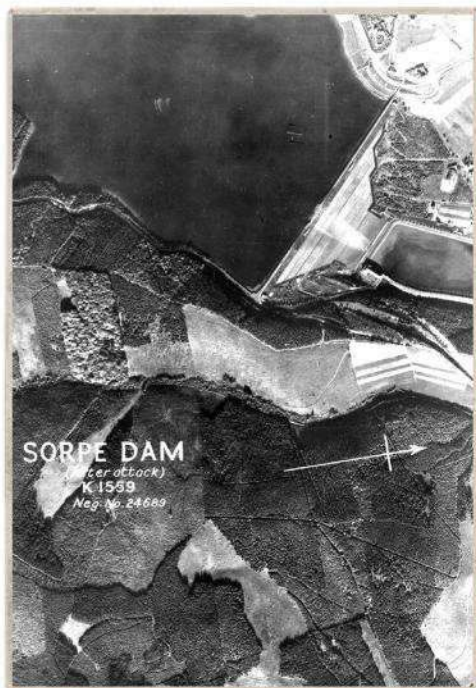
Left: An RAF post-raid photo of the Sorpe Dam showing disturbance in the equalising basin (centre), as water from the reservoir (left) and loose rubble washes over the crest

Bottom-left: One of two towers on the Ennepe Dam. There was a road along its crest (left), and aircraft were ordered to attack across the reservoir from right to left

Bottom-right: The Ennepe Dam, 30 miles (48 kilometres) south west of the Möhne Dam, had a 12.6 million cubic metres capacity and two sluice towers 600 feet (183 metres) apart. Just visible in the top left of the photo is the spit over which the aircraft were to attack

FLIGHT SERGEANT K.W. BROWN (1920-2003)

Ken William Brown was a Canadian, who enlisted in the Royal Canadian Air Force (RCAF) in 1940. After pilot training Brown flew Whitley bombers on Coastal Command maritime operations, then went to a Heavy Conversion Unit (HCU). After that, he flew 13 Bomber Command operations in Lancasters with 44 Squadron before being posted in March 1943 to 617 Squadron. Brown insisted that he did not volunteer and had never met Gibson, but believed that his instructor at the HCU, Flight Lieutenant "Mick" Martin, recommended him. On arrival at Scampton, and having surveyed the array of experienced crews, his wireless operator suggested that they must be at the rear end of the spine of the squadron. During Operation Chastise, Brown's was the only aircraft of the Third Wave to attack the Sorpe Dam, the second Lancaster to do so after another RCAF pilot Flight Lieutenant Joe McCarthy. The structure of the dam meant that, despite an accurate attack, Upkeep only lightly damaged it without causing a breach. On the way back, AJ-F ran into extremely heavy flak at the coast, and Brown was awarded the Conspicuous Gallantry Medal for his determination that night. Subsequently commissioned, Brown returned to Canada in 1945 with an English wife Beryl and was promoted squadron leader before retiring from the Service in 1968 to join the Department of Transport (Air), where he continued to fly.



ITEM 12

**WING COMMANDER
GUY GIBSON'S LOG BOOK**

This extract shows that Gibson first flew with his crew on 1 April 1943. Entries were evidently not made immediately, leading to some confusion. For example, that for 9 April should read "base ... base", and the "Maggie" (Miles Magister) reference is garbled. Gibson probably did fly down to Manston for Upkeep trials on 11 April, but crashed on 13 April on the way back. Entries indicate that, owing to observing trials off Reculver and attending various other meetings, Gibson and his crew undertook only 11 cross-country or dummy attack flights before Operation Chastise, and dropped just one practice Upkeep at Reculver on 11 May.

FORM 414

1

ROYAL AIR FORCE

PILOT'S FLYING

LOG BOOK No 2.

Name W/CMR G. P. GIBSON D.F.C.

YEAR		AIRCRAFT		PILOT, OR 1ST PILOT	2ND PILOT, PUPIL OR PASSENGER	DUTY (INCLUDING RESULTS AND REMARKS)
MONTH	DATE	Type	No.			
—	—	—	—	—	—	TOTALS BROUGHT FORWARD
APRIL	1	LANCASTER	3	SELF	CREW	LOCAL. CREW. P/O TEARBY. P/O SPAFFORD F/LT TREVOR. ROGER P/LT HUTCHINSON P/O DEERING ST PULFORD.
"	4	"	B	"	"	TO Lake NY Sheffield
"	5	"	D	"	"	SCOTTISH X COUNTRY. LAKES.
"	9	"	D	"	"	BASE- DERBENT RESERVOIR
"	11	MAGGIE	—	"	"	- UPPINGWATER. - BASE.
				SELF	F/LT MAY.	LOCAL MANSTON. FINISHED IN FIELD. OK.
"	15	OXFORD	—	SELF	TWO CREW	BASE- READING. FAIROAKS- BASE
"	15	MOSQUITO	4098	S/L LONGBOTTOM (SHORTY)	SELF	FAIROAKS- WEYBRIDGE
"	16	LANCASTER	Y	SELF	CREW	CORNISH X COUNTRY AT LOW LEVEL WITH DUMMY ATTACKS ON LAKES
"	20	LANCASTER	J	SELF	FAY + CREW	NIGHT X COUNTRY TO MANY RESEVOIRS WITH DUMMY ATTACKS

GRAND TOTAL [Cols. (1) to (10)]

.....Hrs.....Mins.

TOTALS CARRIED FORWARD

[illegible]

YEAR 1943		AIRCRAFT		PILOT, OR 1ST PILOT	2ND PILOT, PUPIL OR PASSENGER	DUTY (INCLUDING RESULTS AND REMARKS)
MONTH	DATE	Type	No.			
—	—	—	—	—	—	TOTALS BROUGHT FORWARD
APRIL	21	LANCASTER	D.	SELF	LDEN.	LOCAL. TEST OF SYNTHETIC NIGHT FLYING EQUIPMENT.
"	25	"	D	"	"	HIGH LOW LEVEL X COUNTRY WITH SYNTHETIC N/F SEAR DUMMY ATTACK ON WETON DAITS.
"	27	"	"	"	"	BASE - MANSTON - BASE.
MAY	1	—	H	" S/L YOUNG.	"	TO MANSTON - BASE.
"	2	—	B	"	"	Low Level Recco.
"	3	—	B	"	"	Low Level Bombing. Special Attack. 106mm
"	4	—	B	"	"	MANSTON - LOW LEVEL BASE.
"	5	—	D	"	(DINNY).	BASE - PRANTMAN - BASE.
"	5	—	9	"	"	SPECIAL NIGHT ATTACK.
"	6	"	9	"	"	SPOTLIGHT FLYING AT 60 FT AT NIGHT.

GRAND TOTAL [Cols. (1) to (10)]

.....Hrs.....Mins.

TOTALS CARRIED FORWARD

41

SINGLE-ENGINE AIRCRAFT				MULTI-ENGINE AIRCRAFT						PASS- ENGER	INSTR/CLOUD FLYING [Incl. in cols. (1) to (10)]	
DAY		NIGHT		DAY			NIGHT				DUAL	PILOT
DUAL (1)	PILOT (2)	DUAL (3)	PILOT (4)	DUAL (5)	1ST PILOT (6)	2ND PILOT (7)	DUAL (8)	1ST PILOT (9)	2ND PILOT (10)			
50.25					1.05							40
					5.40							4.00
					2.15.							
50.25	480.50	3.10	2.50	4.20	560.40	16.00	-	630.10		NAV. 87.45	10.55	478.30
					2.00							
					1.25							
					1.55							
					1.50							
					.30							
								3.00				
								1.30				
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)

YEAR 1943		AIRCRAFT		PILOT, OR 1ST PILOT	2ND PILOT, PURIL OR PASSENGER	DUTY (INCLUDING RESULTS AND REMARKS)
MONTH	DATE	Type	No.			
-	-	-	-	-	-	TOTALS BROUGHT FORWARD
MAY	7	LANCASTER	V.	SELF	USUAL CREW	TO MANSTON - BASE.
MAY	8	OXFORD	U	SELF	S/L SMITH	TO HENDON.
"	"	VEGA	?	SELF	F/LT COX	HENDON - MANSTON.
"	"	OXFORD	U	S/L SMITH	SELF	MANSTON - BASE.
"	11	LANCASTER	P.	SELF	USUAL CREW	LOW LEVEL. UPKEEP DROPPED AT 60 FT. PROD RON OF 600 YARDS
"	14	"	P.	SELF	" "	BOOMBING LOW LEVEL AND V.H.F. TEST.
"	14	"	P.	"	" "	"
				P/C WHITWORTH. D.S.O. D.F.C.		FULL DRESS REHEARSAL ON UPPINGHAM LAKE AND COLCHESTER RES. COMPLETELY SUCCESSFUL.
"	16	LANCASTER	G.	SELF	Sgt PULFORD P/O DEERING F/LT TAYLOR ROPER F/LT HUTCHISON P/O SPAFFORD P/O TIERNEY	LED ATTACK ON MÖNNE AN EDER DAYS. SUCCESSFUL.

GRAND TOTAL [Cols. (1) to (10)]

1924 Hrs. 20 Mins.

TOTALS CARRIED FORWARD

[illegible]

ITEM 13**SERGEANT CHARLES
BRENNAN'S LOG BOOK**

Extracts from the log book of Sergeant Charles Brennan, flight engineer of Flight Lieutenant J.V. Hopgood's aircraft, which was hit by flak as it attacked the Möhne Dam. With the starboard wing ablaze, Upkeep was dropped late, bounced over the dam wall and struck the large power station, which was destroyed when the fourth self-destructive device worked after 90 seconds. Meanwhile, Brennan having vainly tried to quell the fire, helped Hopgood boost power so that the aircraft climbed enough for three members of the crew to escape by parachute (two surviving to become PoWs). Preoccupied as he was, Brennan had no chance to get out and his body was one of four found in the wreckage of AJ-M 3.7 miles (6 kilometres) northwest of the Möhne near Ostoennen. The log book, noting that Brennan was missing, presumed dead, was completed by administrative staff at Scampton. The family photo and record of a raid on Bremen with Hopgood, when in 106 Squadron, were enclosed.



B

FORM 1767

ROYAL AIR FORCE

OBSERVER'S AND AIR GUNNER'S
FLYING LOG BOOK

Name

Sgt Brennan

942037.

Sgt Brennan

Instructions.

1. This log book is an official document and the property of H.M. Government.
2. Observers and air gunners will maintain an accurate and detailed record of all flights undertaken on service aircraft.
3. Results of ab initio courses will be recorded on either pages 2, 3, 4 or 5, for which purpose a rubber stamp is available.
4. Proficiency assessments will be recorded on the appropriate page at the back of the book annually on 31st December, on posting or on attachment to another unit for flying duties.
5. Bombing and Air Gunnery records will be entered in the appropriate pages at the back of the book annually on 31st December.
6. Monthly totals will be entered on a single line in red ink and initialled by the Commanding Officer or his deputy.

B3085

26772¹

Certificates of Qualification.

(to be filled in as appropriate)

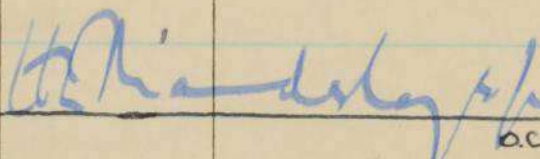
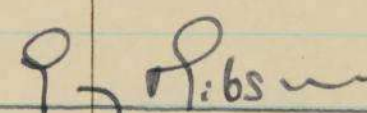
942034

1. This is to certify that C. C. BRENNAN
has qualified as FLIGHT ENGINEER AUTH. 128/42.
with effect from 20.6.42 Sgd. _____
Date _____ Unit _____

2. This is to certify that _____
has qualified as _____
with effect from _____ Sgd. _____
Date _____ Unit _____

3. This is to certify that _____
has qualified as _____
with effect from _____ Sgd. _____
Date _____ Unit _____

4. This is to certify that _____
has qualified as _____
with effect from _____ Sgd. _____
Date _____ Unit _____

Date	Hour	Aircraft Type and No.	Pilot	Duty
21.4.43	21.00	LANCASTER X	F/LT HOPGOOD	FLIGHT ENGINEER
22.4.43	16.00	LANCASTER X	F/LT HOPGOOD	FLIGHT ENGINEER
24.4.43	15.40	LANCASTER R	F/LT HOPGOOD	FLIGHT ENGINEER
25.4.43	10.30	LANCASTER R	F/LT HOPGOOD	FLIGHT ENGINEER
30.4.43	17.45	LANCASTER R	F/LT HOPGOOD	FLIGHT ENGINEER
30.4.43	21.55	LANCASTER N	F/LT HOPGOOD	FLIGHT ENGINEER
		 O.C. "B" FLIGHT		
		 O.C. 617 SQUADRON		

Time carried forward :—

113.40 132.10.

REMARKS (including results of bombing, gunnery, exercises, etc.)	Flying Times	
	Day	Night
BOMBING		00.50
BOMBING	00.40	
CROSS COUNTRY No 3	03.20	
CROSS COUNTRY No 2 BOMBING	02.05	
CROSS COUNTRY	02.00	
LOCAL FLYING		00.50
DAY 28.50 HRS		
NIGHT 11.40 HRS		
TOTAL FOR APRIL 40.30 HRS		
TOTAL TIME ...	121.45	133.50

Date	Hour	Aircraft Type and No.	Pilot	Duty
1.5.43	1320	LANC	F/LT HOPGOOD	FLT. ENGINEER
		N		
2.5.43	1100	LANC	F/LT HOPGOOD	..
		N		
3.5.43	1400	LANC	F/LT HOPGOOD	..
		M		
4.5.43	2100	LANC	F/LT HOPGOOD	..
		P		
4.5.43	2100	LANC	F/LT HOPGOOD	..
		437		
6.5.43	1330	LANC	F/LT HOPGOOD	..
		925		
9.5.43	1400	LANC	F/LT HOPGOOD	..
		925		
11.5.43	1000	LANC	F/LT HOPGOOD	..
		925		
11.5.43	1730	LANC	F/LT HOPGOOD	..
		925		
9.5.43	2100	LANC	F/LT HOPGOOD	..
		925		

Time carried forward :—

1245 133.50

REMARKS (including results of bombing, gunnery, exercises, etc.)	Flying Times	
	Day	Night
BOMBING	1.50	
BOMBING	1.10	
TEST.	.55	
TEST	.20	
NIGHT TACTICS		1.50
LOW LEVEL TO MANSTON	2.00	
TACTICAL PRACTICES	1.10	
TO & FROM MANSTON	2.10	
V. H. F. TESTS	.55	
NIGHT x/c TACTICAL EXES		1.50
TOTAL TIME ...	131.55	137.30

Time carried forward :-

11.55 137.30

Date	Hour	Aircraft Type and No.	Pilot	Duty	REMARKS (including results of bombing, gunnery, exercises, etc.)	Flying Times	
						Day	Night
15.5.43	1330	LANC	Ft HOGROD	ENGINEER	BOMBING + TACTICAL PRACTICES	1.25	
15.5.43	2200	LANC	Ft HOGROD	"	1/2 NIGHT PRACTICES		2.50
17.5.43		LANC	Ft HOGROD	"	N.F.T. FORMATION BOMBING	.50	
17.5.43		LANC	Ft HOGROD	"	FORMATION EXERCISE		1.30
16.5.43	2130	LANC	Ft HOGROD	ENGINEER	OPERATIONS MOHINE DAM		
					MISSING -		
					MONTHLY FLYING	12.25	
					NIGHT		7.40
					TOTAL	134.10	141.30
					<i>Signature</i> for OC B.F.T.		
					TOTAL TIME ...		

Signature 5/6 for report
OC 617 SQDN.

Date	Hour	Aircraft Type and No.	Pilot	Duty
<p><i>Death Presumed</i></p> <p><i>14. 5. 43.</i></p>				

IMPACT GERMANY

In the wake of the raids, it seemed that the damage was done

The adjacent breaches caused by Young and Maltby at the Möhne left a gap 250 feet (76 metres) broad and 72 feet (22 metres) deep. Hopgood's Upkeep had bounced over the wall to demolish the power station, whose 20-ton turbine was swept away. Floodwater rapidly progressed through the narrow Möhne valley into the Ruhr river and on to its junction with the Rhine almost 95 miles (150 kilometres) away, leaving a trail of destruction in its wake.

In all, below the Möhne 11 factories were destroyed and 114 damaged; 25 road and rail bridges were broken and 21 damaged; some 9,900 acres (4,000 hectares) of arable land were swamped; and numerous power stations, pumping stations, and water and gas facilities were damaged or destroyed. An inadequate warning system and the slow official reaction contributed to 1,294 civilian casualties.

At the Eder, the breach was 230 feet (70 metres) wide by 72 feet (22 metres). The flood travelled slower and spread further in the wider valleys below. Nevertheless, it ultimately reached Interschede near Bremen, 264 miles (425 kilometres) from the dam. Power stations at or near the Eder were destroyed, several road and rail bridges were damaged or destroyed, and Fritzlar military airfield was inundated. As in the Ruhr, agricultural land was

heavily affected. Although no direct impact on the Mittelland Canal was reported, the Weser and Fulda rivers were badly hit. 39,000 cubic yards (30,000 cubic metres) of soil had to be dredged from the Fulda, and 6,500 cubic yards (5,000 cubic metres) from the Weser to restore navigable channels; and about 3.5 miles (5.5 kilometres) of the Weser's banks had to be reconstructed, with a consequent interruption to transport of war materiel. Forty-seven lives were lost below the dam.

At the Sorpe, McCarthy and Brown had dropped Upkeep accurately. However, contrary to expectations, when they exploded on the sloping support, most of the blast went upwards. The dam basically "remained undamaged", but the Germans recorded two "craters" below the waterline 26 feet (eight metres) wide and 15 feet (4.5 metres) deep, while the concrete wall stripped "to a depth of several metres" on the water side and 230 feet (70 metres) was torn away from the crest. No damage was reported at the Ennepe.

Most of the immediate activity was in the vicinity of the breached dams. Albert Speer, Minister for Armaments and Munitions, was summoned from his bed and sent to survey the carnage. Inspecting the area over two days, he concluded that the bombers had "tried to strike at our whole armament industry by destroying the hydroelectric plants of the Ruhr."

Speer reported that "the electrical installations at the pumping stations were soaked and immobilised, so that industry was brought to a standstill." The effect on the waterway transport system below the Eder caused grave concern, too.

Speer rapidly drew up plans to bring specialist help and equipment from across Germany in order to restore services, being prepared to denude "other factories, regardless of the consequences." Above all, he aimed to repair the broken dams before the autumn rains.

His efforts were quickened by the "deep impression" the raid had made on Hitler, who referred to "this disaster in the west". The Führer was particularly furious with the Luftwaffe, whose officers sought to excuse their failure to act decisively because the Lancasters flew so low. None of the aircraft lost fell to a night fighter.

Forty-eight hours after the raid, Hitler approved Speer's plans to repair the damage and restore services. Seven thousand technicians and specialist workers were to be withdrawn from elsewhere to the Ruhr, Eder and districts below that dam. In addition, 20,000 Todt Organisation labourers were taken away from projects like the Atlantic Wall.

The impact on regions outside the directly affected areas was, therefore, extensive.



THE BREACHED MOHNE

In their post-operational questionnaires, Gibson and Maltby confirmed two breaches in the Möhne Dam (by Young and Maltby), which left a gap larger than expected through which the torpedo nets were dragged and beached on the side of the compensating basin beyond the dam. Two power stations, one with 4,800kW capacity below the wall and the other with 300kW capacity on the edge of the basin, were demolished, and the 20-ton turbine from the former washed downstream. 152 million cubic yards (116 million cubic metres) from the 172.9 million cubic yards (132.2 million metres) contained by the dam flowed out of the reservoir in 12 hours. So swift was the initial outflow that water from feeder ponds above the dam could not escape quickly enough, which damaged retaining dykes. The tidal wave, which swept through the Möhne valley was 33 feet (10 metres) high, exceeded the height of the floods partly responsible for building the dam in 1890. Neheim at the junction of the Möhne and Ruhr rivers only learnt of the breach as the water reached it.



Opposite-left: After the flooding had subsided...
A German photo showing the damage caused by
the attack on the areas surrounding the dam



Opposite-bottom: The Eder Dam from air side.
The reservoir beyond the breach has almost
drained and water is pouring through emergency
sluices. The wrecked power station is visible left,
and the empty equalising basin centre

Top-right: Nazi officials and representatives of
the Todt Organisation examine repair work. Note
the boards over the tracks for a light railway
along the crest of the dam

Top-left: Mechanical equipment swept away by
the flooding

Right: Affoldern (flooded bottom) in the valley
2 1/2 miles (4km) below the Eder Dam on the
morning after the raid

Below: Inhabitants begin to clear up after the
devastation after the floods had subsided – the
height of which can be judged by the damaged
building (centre)



THE BREACHED EDER

All three attacking aircraft caused damage to the Eder Dam. Flight Lieutenant Shannon claimed to have "made gap 9ft wide towards the east" (right-hand side from the valley) and undoubtedly damage did occur in this area. Squadron Leader Maudslay's Upkeep hit the top of the dam wall and most of the explosion went upwards, but it damaged the road along the crest and the ashlar parapets at its sides. Later reports suggested that lateral cracks were also caused in the structure of the dam. Pilot Officer Knight's Upkeep created a V-shaped gap just right of centre. At the bottom of the breach, the wall was 59 feet (18 metres) thick and an estimated 30,000 tons was lanced from the structure. 201.9 million cubic yards (154.4 million cubic metres) out of 264.7 million cubic yards (202.4 million cubic metres) in the reservoir escaped in 48 hours. Although the valley below the dam was much wider than at the Möhne, floods 39 feet (12 metres) high and 26 feet (eight metres) wide were reported.



EPIC FEAT OF ARMS

In a matter of days, the Dambusters became national heroes

On the morning after the raid the BBC made the following announcement: "This is London. The Air Ministry has just issued the following communique. In the early hours of this morning, a force of Lancasters of Bomber Command led by Wing Commander GP Gibson DSO DFC attacked with mines the dams of the Möhne and Sorpe reservoirs ... (which) control two-thirds of the storage capacity of the Ruhr Basin." The announcer added that the Eder Dam further east, "which controls the head waters of the Weser and Fulda valleys" had also been attacked.

Already, Air Vice-Marshal Cochrane had signalled Gibson from Grantham: "All ranks in 5 Group join me in congratulating you and all in 617 Squadron on a brilliantly conducted operation." From Coastal Command, its commander, who as an Air Ministry staff officer had been involved in pre-war plans, wired: "Well done Scampton. A magnificent night's work. Slessor." From Washington, the CAS (Portal) sent "heartiest congratulations".

Nor was Wallis forgotten. Cochrane revealed "how much I admire the perseverance which brought you the astounding success which was achieved last night." Harris telegraphed: "We in Bomber Command in particular and the

United Nations as a whole owe everything to you ... for the outstanding success achieved." Gibson wrote: "All my pilots and I are honoured that we had the opportunity to take part in the last great experiment which has proved all your theories." Messages came, too, from a wide variety of institutions and individuals with whom Wallis had worked in the build-up to the operation. Making use of reconnaissance photos, interviews with participants and reports from correspondents in neutral countries like Switzerland and Sweden, the British press embellished official announcements. *The Daily Mail* described "The Smash-Up: RAF Picture Testifies to Perfect Bombing" and concluded that "the devastation done to Germany's war machine has probably only just begun." *The Illustrated London News* praised "A Titanic Blow at Germany: RAF Smash Europe's Mightiest Dams." Pamphlets with photos of the broken dams were dropped on occupied countries in Europe. Abroad, *The New York Times* declared that "The RAF has secured another triumph and with unexampled daring, skill and ingenuity it has blasted two of Germany's important water dams." On Wednesday 19 May, Winston Churchill mentioned the raid in his speech to Congress and received a standing ovation. At the allied Trident conference, "Admiral Leahy, on behalf of the US Chiefs of Staff, offered Sir

Charles Portal congratulations on the success of the RAF in this operation." In Parliament, Rear-Admiral Sir Murray Sueter paid tribute to "the great air attack" by "our gallant pilots".

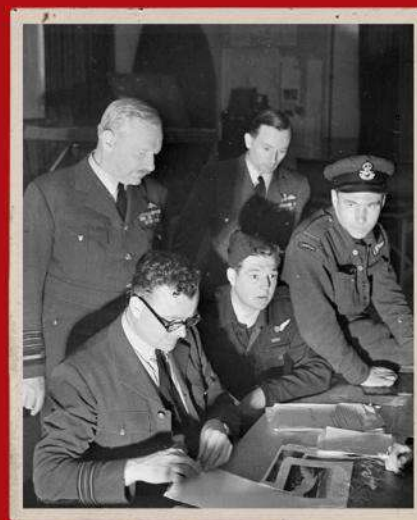
On 27 May, survivors of the raid were presented to the King and Queen at Scampton, the scenes being preserved in still photographs and newsreels. Pilots were shown introducing their crews, the King examining photos of the damage at and below the dams and choosing a Squadron crest – a shattered dam with the words "Après Moi le Déluge". There was one personal postscript to the occasion. Learning that it was the twenty-first birthday of the Australian Flight Lieutenant Shannon the King encouraged him to celebrate accordingly. He did, "by royal command".

The London Gazette had already announced 34 awards to those who had flown to the dams, headed by Gibson's VC. At Buckingham Palace on 22 June, the Queen invested the recipients, less one who was sick. Once more at home and overseas the press highlighted the operation. *The New York Times* printed a photo of Flight Lieutenant McCarthy with his DSO, and publications in New Zealand, Canada and Australia had photos of their own nationals at Scampton and the Palace. As Sir Archibald Sinclair exclaimed, they were celebrating "an epic feat of arms".



DEBRIEFING

In addition to the normal questions from an intelligence officer (seated, left), each pilot had to complete a special questionnaire. He had to describe visibility at the target, the number and height of Upkeep's bounces, the number of revolutions per minute at which the weapon was spun, the explosion itself and damage to the target, the effectiveness of the control system at the target and value of 100 per cent tracer. Shannon, Flight Lieutenant Maltby and Flight Sergeant Townsend were among those to enthuse about the routes, which were "easy to map read". Opinion on 100 per cent tracer was decidedly mixed, though. Gibson thought it "perfect for this job", Maltby "no trouble and easier to aim". But Pilot Officer Knight had reservations, claiming that it dazzled his gunners. Similarly Flight Sergeant Brown found it "very dazzling, ordinary night tracer preferred", and Flight Lieutenant McCarthy declared himself "not in favour ... (as it) betrayed position of aircraft to searchlights and light flak en route". Townsend, the last pilot to return, used the space for extra comment to complain of drifting mist and dazzle from the moon in the target area, adding: "Consider timing too late as we were still over Germany in daylight."



"EACH PILOT HAD TO FILL A SPECIAL QUESTIONNAIRE"

Opposite-bottom-left: King George VI being briefed on the operation by Gibson (left), and Group Captatin J.N.H. Whitworth, the station commander at RAF Scampton on 27 May 1943

Bottom-right: A celebratory dinner given by A.V. Roe & Co. at the Hungaria Restaurant in London on 22 June 1943. Test pilots "Mutt" Summers (15) and "Sam" Brown (5). Barnes Wallis (16) and Roy Chadwick (29). Raid pilots Munro (4), Martin (19), McCarthy (23), Maltby (24) and Gibson (25)

Below: Plt Off L.G. Knight DSO RAAF being presented to King George VI, 27 May 1943. In September, Knight sacrificed his life for his crew when attacking the Dortmund-Ems canal

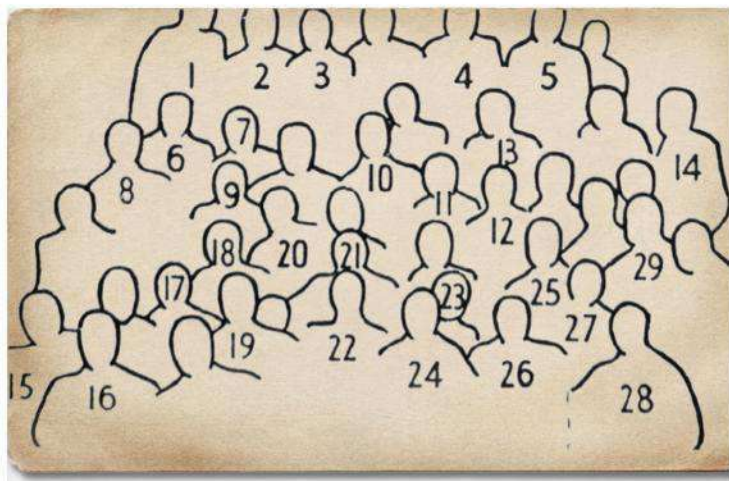
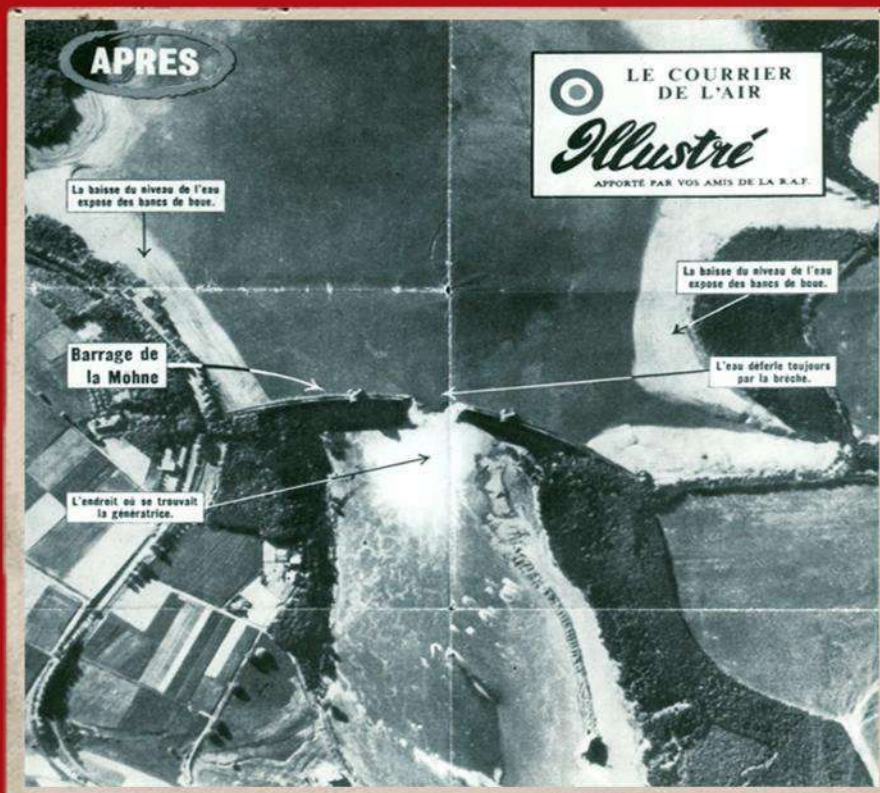
Below-middle: Flt Lt H.B. "Mick" Martin DSO DFC RAF being presented to King George VI, 27 May 1943, by Gibson and Whitworth (centre)



LEAFLETS

Photographs taken by reconnaissance aircraft of the target dams before and after the raid were used to boost morale in the occupied countries of Europe via leaflets dropped within days of Operation Chastise. The photographs were accompanied by a lengthy explanation of the nature and execution of the operation, together with various diagrams depicting the scale of anticipated damage. In *Le Courier de l'Air Illustré*, French readers learnt that the raid was "one of the greatest successes of the RAF ... mines of more than 7,000 kilos (were dropped) on the dams, which served the war industries of the Ruhr." Breaches of almost 328 feet (100 metres) were claimed in the

Möhne and Eder dams and, optimistically, the Sorpe. At the Möhne, water pouring through the gap in the wall exposed shores of the reservoir and the spot where the large power station had stood were highlighted. "The attack ... has resulted in material destruction of factories, which will be further increased by the loss of water when the floods abate." An accompanying diagram "illustrating the effects of the breach in the Möhne Dam" suggested that a swathe of industrial centres north and south of the Ruhr river, including Dortmund, Essen, Bochum, Dusseldorf and Hagen were affected. Similar information appeared in the edition of *De Vliegende Hollander* dropped over the Netherlands.



ACTION GERMANY 1943–1944

With winter well on its way, Germany sought to repair the damage to the dams

On 17 May, a German report concluded, “it is not known yet what type of explosive was employed (torpedo, mine or bomb)”. Not for long. In his account of the operation at the Möhne, dated 30 September, Dr. Pruess wrote: “The nature of the bombs has already been established from an aircraft which crashed on the lower Rhine on the way in.”

The Upkeep carried by Flight Lieutenant Barlow’s Lancaster, which crashed near Rees, had not detached from the aircraft. So the self-destruct device had not worked, and Upkeep was recovered intact from the wreck. A preliminary report on 30 May was followed by a thorough analysis in the first week of July. It included a comprehensive description of the modified Lancaster and Wallis’s weapon, together with numerous detailed illustrations under the heading *Britische Rotations-Wasserbombe 3,900kg* (British Revolving Depth Charge, 3,900kg) – a more accurate description than “bouncing bomb”. From markings, the Germans identified a Mark XIV depth charge, which had been dropped “from a low-flying aircraft in advance of the target”.

The Germans realised that the motor, which drove the belt to rotate Upkeep, used power normally to operate the bomb-bay doors. How the calliper arms retained Upkeep, and the properties of the weapon such as pistols, nuts and endplates were meticulously explained and illustrated. The Germans worked out there were three hydrostatic pistols and, in case they failed, another set to detonate after a delay following release. Although scientists deduced back-spin, they assumed this was to ensure stability during the release phase. That Upkeep bounced over the water was not understood. Insistence on re-checking all the available data over 18 months meant that a German version was never developed. Meanwhile, strenuous efforts were being made to fill the gaps in the

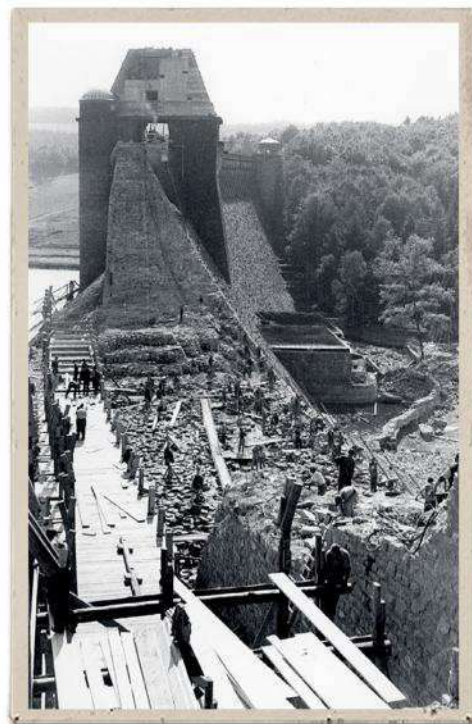
Möhne and Eder dams; and flak guns, balloons and smoke canisters were rapidly deployed to protect the workforce.

Before the end of September, the gaps in both dams had been filled in, all of them being sealed by pressure grouting. The damaged parapets at neither dam were replaced and some repairs were temporary, but the reservoirs were ready to hold water from the winter rains. Below each of them, labourers also tackled damaged roads and replaced bridges with wooden structures, which would be made permanent after the war.

Beyond providing protection of workers in the short-term, more military personnel and their equipment were stationed permanently at the Möhne, Eder, Sorpe, Ennepe and six other dams considered vulnerable to aerial attack. At the Eder, for example, 24 20mm, four 37mm and eight 88mm flak guns were stationed, together with six rocket-carrying vehicles (each with 24 dischargers), 48 balloons and 500 smoke pots to produce a smokescreen. An estimated 1,000 regular troops at each dam were supplemented by reserves to deal with possible paratroopers.

During the winter, an impressive array of passive defences were installed, too. At the Möhne, an aerial wire attached to pylons mounted on each bank was hung across the reservoir, a third torpedo net provided, wooden deflectors sunk in front of the dam and struts with netting in-between protruded on the air side to foil rocket attacks. At the Eder, wooden stakes attached to buoys were sunk in front of the dam, three torpedo nets put in place and several rows of mines set to be activated by water turbulence caused by low-flying aircraft.

“Bomber” Harris was therefore justified in claiming that the diversion of personnel and equipment from other tasks, such as the defence of industrial targets, was a direct response to the threat posed to Germany by Operation Chastise.



MÖHNE REPAIRS

The Todt Organisation assumed responsibility for immediate repairs to the Möhne Dam, where approximately 23,000 cubic yards (17,600 cubic metres) of “cyclopean rubble masonry of the same type as the original construction” plugged the gap. On the air side, a deep hole scoured as water escaped from the reservoir was filled with a block of about 13,000 cubic yards (9,900 cubic yards) to give additional support to the base of the dam. This work had been completed by 23 September, and a celebratory party duly took place on 2 October. Besides the military defences already deployed, during the winter thoughts turned to further passive provisions to frustrate another low-level air attack. In addition to pylons set on each side of the reservoir with cables slung low between them and netting attached to the air side, plans were discussed for 44 floating wooden deflectors to protect the dam wall and for a third torpedo net. A dispute about how much the level of the water in the reservoir should be lowered as part of the defence system delayed work, but the deflector systems was completed on 8 May 1944. The third torpedo net, 15.7 inches (400 millimetres) thick and 2, 132 feet (650 metres) long, was completed under the supervision of German Navy personnel on 25 May, together with six associated buoys. It stood 20 feet (six metres) from the two existing nets 3.9 inches (100 millimetres) thick, between them and the dam.

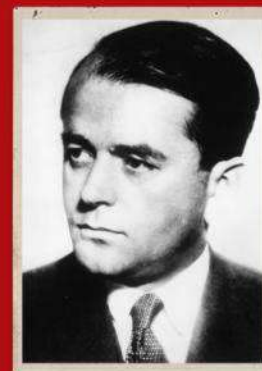
ALBERT SPEER (1905–81)

Albert Speer became an architect, like his father and grandfather, and was lecturing at the Technical University of Berlin when he joined the Nazi Party in 1931. He swiftly established himself by helping to design the Olympic Stadium (1936) and the German pavilion at the Paris Exhibition (1937). He used searchlights to create "a cathedral of light" for the Nuremberg rallies, redesigned the Reich Chancellery and became a close associate of Adolf Hitler, about whom he said "All I wanted was for this great man to dominate the globe."

When war broke out, he was planning a grandiose rebuilding of Berlin, and in 1942 succeeded Fritz Todt as Minister for

Armaments and Munitions. In the early hours of Monday 17 May 1943, he received "most alarming" news that the Möhne Dam had been "shattered", its reservoir "emptied" and "three other dams" attacked. Landing at nearby Werl airfield in a Fieseler Storch shortly after dawn, Speer spent two days surveying the affected areas.

He secured Hitler's personal approval for 27,000 specialists and labourers to deal with the damage and assumed overall control of the repair of the Möhne and Eder dams. Joseph Goebbels wrote: "Speer is truly a magnificent genius." He was sentenced to 20 years in prison at the Nuremberg War Trials.

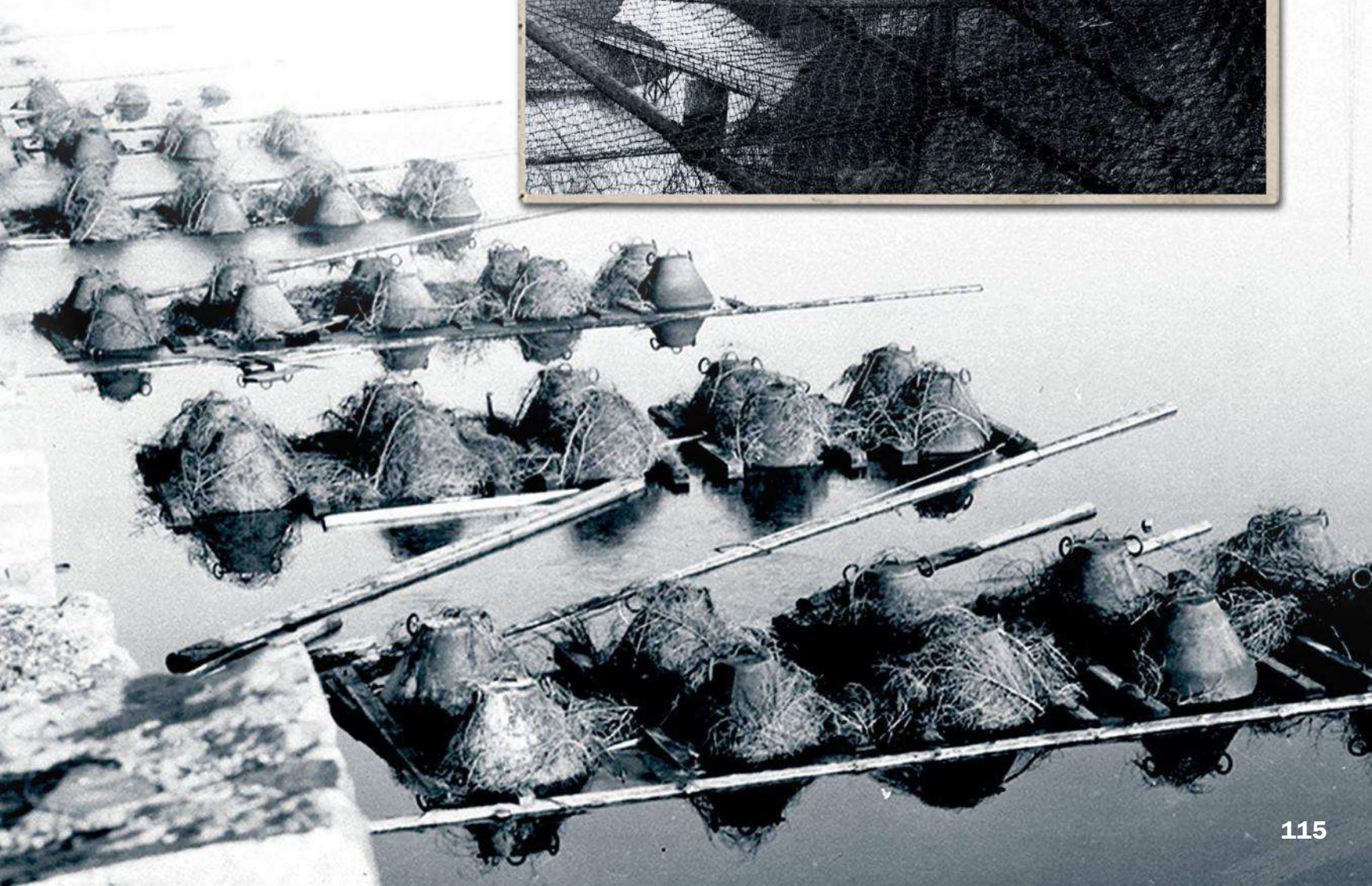


Opposite-bottom: The repair work on the the Möhne Dam viewed from air side, showing the flattened towers and supports put in place for protective netting. The area of the dam which was breached has now been filled with lighter masonry, clearly showing the full extent of the damage

Opposite: Repairs to the Möhne Dam in progress. Work is being done on plugging the gap between the two towers. The tower at the centre of the image had the flak gun blown off during the raid

Right: Post-operational defences. The air side of the Möhne Dam with netting in position to counter-attack the bombs

Below: Buoys supporting an underwater stockade to protect the Möhne Dam from attack following Operation Chastise



ITEM 14

617 SQUADRON OPERATIONS RECORD BOOK

617 Squadron's summary of the Dams Raid identified the Möhne, Eder and Sorpe dams as "primary targets", and Lister, Ennepe (mistyped as Ennerpe) and Diemel as "alternative targets". Third Wave aircraft were briefed to attack the latter three, but would only do so after receiving "direct orders in the air". Otherwise, they were to proceed to the Möhne and Eder dams. The positions and numbers of flak guns at the Möhne are slightly inaccurate, but two "successful attacks" there - by Young and Maltby - and on the Eder by Shannon and Knight - are confirmed. Otley's loss near Hamm is wrongly attributed to Young and Rice's Upkeep did not explode as believed.

OPERATIONS RECORD BOOK							APPENDIX.....	R.A.F. FORM 541.
DETAIL OF WORK CARRIED OUT								
By No. 617 Squadron.							SECRET	
FOR THE MONTH OF May 1943.							PAGE No.	
DATE	AIRCRAFT TYPE & NUMBER	CREW	DUTY	TIME		DETAILS OF SORTIE OR FLIGHT	REFERENCES.	
				Up	Down			
SUMMARY OF OPERATION CARRIED OUT BY SQUADRON ON 16/17th. May. 1943.								
<p>On the night of 16/17th. May, 1943, nineteen aircraft of No. 617 Squadron took off to breach a number of important Dams in and around the Ruhr area. There were three primary targets, namely the Möhne, the Eder and the Sorpe Dams, and three alternative targets, the Lister, the Ennerpe and the Diemel Dams.</p> <p>The Squadron trained for six weeks, paying particular attention to map reading and accurate low level bombing.</p> <p>The attack was divided into three waves. The first wave of 9 aircraft subdivided into three sections of three aircraft each, took off at 10 minute intervals, in perfectly clear weather, and with a full moon to assist them. They were detailed for the Möhne and the Eder Dams, in that order of priority. The second wave, consisting of five aircraft, took off to attack the Sorpe Dam, taking a different route, but timed to cross the enemy coast at the same time as, though at different points from, the leading section of the first wave. The third wave, consisting of the remaining five aircraft, formed an air bomb reserve and took off three hours later, each detailed for one of the alternate targets, and all detailed to be prepared to attack the Möhne or Eder Dams in the absence of any direct orders in the air to carry on to the alternative targets.</p> <p>Wing Commander Gibson, on route to the target leading the first section of the first wave, met about twelve searchlights, and some concentrated light flak at the lakes 10 miles N.E. of Haltern, which was reported to Group by W/T, and passed by Group to all the other aircraft. On arrival at a point 10 miles from the Möhne Dam, the formation went over to R/T control, and each individual attack was controlled by W/Cdr. Gibson. There were between seven and ten light flak guns around the target, believed to be mainly 20 mm. One or two were located on the Dam itself, and there were two positions on the N bank of the lake on each side of the Dam. W/Cdr. Gibson attacked first and dropped his load accurately. Four other aircraft then attacked under his control, one of which was seen to be hit by light flak during its run up, and overshot with its load. The Dam was seen to breach on the fifth attack, and this was reported to J. Group by W/T. The remaining four aircraft were then diverted to the Eder Dam, one of these however had been shot down on the way to the target, and only three attacked. One load was seen to overshoot, and this Dam was seen to breach, after two successful attacks. This fact was also reported by W/T to Group Headquarters.</p> <p>Of the five aircraft detailed to attack the Sorpe Dam, two returned early, one is known to have attacked, and two are missing without trace. A sixth aircraft from the mobile reserve was also detailed by W/T. to attack the target, and did so successfully. The two aircraft attacking both reported that the crest of the Dam was seen to crumble for some considerable distance.</p> <p>Two of the remaining four aircraft of the mobile reserve were detailed to attack the Sorpe Dam, one attacked successfully and one is missing, and it is believed did not attack. The fourth aircraft was detailed by W/T. to attack the Lister Dam, and acknowledged the order. There is no further trace of him, and it is not known if he attacked it. The fifth aircraft successfully attacked the Dam at Ennepe.</p> <p>The most important consequence of this operation is that the Ruhr industries will be deprived of a great deal of their industrial water for the coming summer. The immediate effect of the floods from the two Dams breached was to cause devastation and disruption throughout the valley of the Ruhr as far Duisburg, and serious flooding below the Eder Dam at Kassel, and other places down the Weser Valley.</p>								

OPERATIONS RECORD BOOK

APPENDIX

RAF
FORM 541

DETAIL OF WORK CARRIED OUT

By 617 Squadron

SECRET

PAGE No.

(2011) WE 9401-25 60000 141 T.R. 700
(2011-1991) WE 9401-245 7000 1409 T.R. 700

FOR THE MONTH OF May 1943

DATE	AIRCRAFT TYPE & NUMBER	CREW	DUTY	TIME		DETAILS OF SORTIE OR FLIGHT	REFERENCES
				Up	Down		
1943 May 16/17	Lancaster III ED. 9328.	W/Cdr. A.P. GIBSON SGT. KILFORD J. P/O. H.E. TAYLOR P/Lt. R.E.G. HUTCHISON P/O. F.E. SEAFORD P/SGT. G.A. BRESLIN P/Lt. H.D. TREVOR ROGER	CAPTAIN. P/ENG. NAV. W/OPT. A/B. P/GUNNER. P/GUNNER.	2139	0415	MOINE DAM. 1 Mine. 60ft. 0028hrs. Identified the target and carried out first attack on the Moine Dam. Came under light flak from guns around the target, but dropped his mine accurately and then directed the remainder of the attack by R/T. He also flew alongside one a/c as it attacked, machine gunning the defences to allow it to attack undisturbed. He then carried on to the Eder Dam and indicated the target to searching a/c and stayed to assess the results.	G.
	ED. 9256.	P/Lt. J.V. HOGWOOD. SGT. BRENNAN C. P/O. K. BAINSHAW. SGT. MURCHIN J. P/SGT. FRASER J.W. P/O. G.H. GREGORY. P/O. A.P. BURCHER.	AS SHOWN ABOVE.	2139	-	MOINE DAM. 1 Mine. Was seen to be hit by flak on the run-up and to have engine on fire. He overshot with his mine, which struck the parapet, and then flew on for a few minutes before crashing in flames. It is believed that he may have climbed sufficiently for some members of his crew to escape by parachute.	M.
	ED. 9096.	P/Lt. H.B. MARTIN. P/O. T. WHITTING. P/Lt. J.F. LEDGO. P/O. L. CHAMBERS. P/Lt. H.C. HAY. P/O. B.T. FOXLEE. P/SGT. SIMMONS T.D.	AS SHOWN ABOVE.	2139	0319	MOINE DAM. 1 Mine. 60ft. 0038 hrs. Mine burst about 20 yds. short. Starboard outer fuel tank and ailerons damaged by cannon fire. Aircraft landed safely at base.	F
	ED. 8776.	P/Lt. H.E. YOUNG. SGT. HODSFORD T. SGT. ROBERTS C.W. SGT. NICHOLS L. P/O. V.S. MACCAUSLAND SGT. YEO A.G. SGT. IBBOTSON L.	AS SHOWN	2147	-	MOINE DAM. 1 Mine. Missing. Was seen to make an accurate attack with his mine and then accompanied W/Cdr. Gibson to the Eder Dam, and back to the Moine, when the attack was finished. He was not heard on R/T after this, and is believed to have flown over Hamm on the return journey and been shot down there.	A
	ED. 9066.	P/Lt. D.J.H. MALTBY SGT. HATTON J. SGT. NICHOLSON V. SGT. STONE A.J. P/O. J. FOLT. SGT. HILL E. SGT. SHIMMONS D.	AS SHOWN ABOVE.	2147	0311.	MOINE DAM. 1 Mine. 60ft. 0139 hrs. Made a direct hit with his mine, and the Dam was seen to breach.	J

DATE	AIRCRAFT TYPE & NUMBER	CREW	DUTY	TIME		DETAILS OF SORTIE OR FLIGHT	REFERENCES
				Up	Down		
1943 May 16/17	Lancaster III ED. 9298.	P/Lt. D.J. SHANNON. SGT. HENDERSON R. P/O. F.E. WALKER P/O. B. GOODALE. P/SGT. SUMPTER R.J. SGT. J. GIER B. P/O. J. BUCKLEY.	CAPTAIN. P/ENG. NAV. W/OPT. A/B. P/GUNNER. P/GUNNER.	2147	0406	EDER DAM. 1 Mine 60 ft. 0139 hrs. Diverted from the Moine to the Eder Dam, attacked first and registered a direct hit, but no result was seen.	L
	ED. 9376.	P/Lt. H.E. MAUDSLAY. SGT. MARRIOTT J. P/O. E.A. URQUHART. SGT. COTTAM R. P/O. M.J.D. FULLER. P/O. W.J. TYTHERLEIGH SGT. N.C. BURROWS.	AS SHOWN ABOVE.	2159	-	MOINE DAM. 1 Mine. This aircraft is believed to have been damaged on the way to the target, as something that could not be identified was seen by the light of the moon to be hanging underneath it. The mine overshot and struck the parapet, detonating instantaneously. The pilot was spoken to afterwards by R/T. and was heard to reply once, when he sounded very weak.	
	ED. 8646.	P/Lt. W. ASTELL. SGT. KINNEAR J. P/O. E.A. WILE. SGT. GERSHONITZ A. P/O. D. HENDERSON. SGT. GARRAS F. SGT. BOLITHO R.	AS SHOWN ABOVE.	2159	-	MOINE DAM. 1 Mine. When leading his formation on the way to the target, appeared to become uncertain of his whereabouts, and on reaching a canal crossing, actually at the correct place, turned S. down the canal, as though to search for pinpoint. He fell about 1 mile behind his accompanying aircraft, doing this, and got slightly off track. He is believed to have been shot down by light flak shortly afterwards.	B.
	ED. 912 G.	P/O. L.G. KNIGHT. SGT. GRAYSTON R. P/O. H.S. HODDAY. P/SGT. KELLOW R.G. P/O. E.C. JOHNSON. SGT. SUTHERLAND R. SGT. PHILLIPS.	AS SHOWN ABOVE.	2159	0420	EDER DAM. 1 Mine. Was the third aircraft to attack the Eder Dam. He made two runs and released his mine on the second one, making a direct hit and breaching the dam.	
	ED. 9216.	P/Lt. E.L. MINGO. SGT. AFFERTY F. P/O. F.G. RIMBLEES. SGT. FIBSON P.E. SGT. CLAY J.H. SGT. HOWARTH W. P/SGT. WOODS E.	AS SHOWN ABOVE.	2129	0036	SOERRE DAM. 1 Mine. Aircraft was hit by light flak and at Vlieland on the way to the target, which put the intercom out of action and forced the aircraft to return with his load to base.	

R.A.F.
FORM 541

DETAIL OF WORK CARRIED OUT

By No. 617 Squadron.


SECRET

PAGE No.

(*9511) Wt. 955—55 60,000 9/42 I.R. 700
(*1004—0422) Wt. 9511—2145 105M 12/42 I.S. 700

FOR THE MONTH OF May 19 43

DATE	AIRCRAFT TYPE & NUMBER	CREW	DUTY	TIME		DETAILS OF SORTIE OR FLIGHT	REFERENCES
				UP	DOWN		
	Lancaster III ED. 8650.	P/O. L.J. BURGESS SGT. EDWARDS B. SGT. JAYE T. P/O. L.G. WESSLER. SGT. ARTHUR R. SGT. LONG N. P/SGT. BRADY J.G.	CAPTAIN. P/ENG. NAV. W/OPTG. A/B. P/G. R/G.	0011	-	SORPE DAM. 1 Mine. Missing without trace.	S
	ED. 6860.	P/SGT. TOWNSEND W.C. SGT. FOWLER D.J. P/O. C.H. HOWARD. P/SGT. CHALMERS G. SGT. FRANKLIN C.E. SGT. WEBB D.E. SGT. WILKINSON J.	AS SHOWN ABOVE.	0014	0615	SORPE DAM. 1 Mine. 60ft. 0337 hrs. Blast on the reservoir caused this aircraft to make 3 runs at the target. Mine dropped accurately on third attempt and seen to explode. Returned over Holland in broad daylight.	O
	ED. 9183.	P/SGT. BROWN K.W. SGT. FENNERON H.B. SGT. HEAL D.F. SGT. HEWSTONE H.J. SGT. GANCHA S. SGT. ALLATSON D. P/SGT. MACDONALD G.	AS SHOWN ABOVE.	0012	0233	SORPE DAM. 1 Mine. 60 ft. 0314 hrs. Shot up a train on the way to the target, on arrival at the target, was hampered by mist, so dropped some incendiaries in some trees, and used the resulting fire as a landmark whilst waiting for the mist to clear. Dropped mine accurately and saw it explode.	F
	ED. 9243.	P/SGT. ANDERSON G.T. SGT. PATTERSON D. SGT. MURPHY L. SGT. HICKLE D. SGT. GREEN S. SGT. EVAN A. SGT. BUCK R.	AS SHOWN ABOVE.	0015	0530	SORPE DAM. 1 Mine. Was unable to reach target, due to mist in valleys, mine returned to base.	Y


 WING COMMANDER,
 COMMANDING, 617 SQUADRON, R.A.F.

WING COMMANDER.

COMMANDING, 617 SQUADRON, R.A.F.

"617 SQUADRON'S SUMMARY OF THE DAMS RAID IDENTIFIED THE MÖHNE, EDER AND SORPE DAMS AS PRIMARY TARGETS, AND LISTER, ENNEPE AND DIEMEL AS ALTERNATIVE TARGETS. THIRD WAVE AIRCRAFT WERE BRIEFED TO ATTACK THE LATTER THREE, BUT WOULD ONLY DO SO AFTER RECEIVING DIRECT ORDERS"

Page No.

Place	Date	Time	Summary of Events	SECRET.	References to Appendices
	15.5.43		P/O. AL. WHITTAKER CD (A/S) reposted to Squadron on appointment to commission. (144777)		
			P/O. S.L. WITLIS 144519 2D(P/S) reposted to the Squadron on appointment to commission.		
			Flying Training prior to operations completed to-day.		
	16.5.43		A special operation for which this Squadron had been training so hard was carried out. The target was the three great German Dams, the Eder, the Möhne and the Sorpe. 19 aircraft took off to attack the target, and of these, 8 failed to return. The attack was an outstanding success in spite of these losses, and the Eder and the Möhne Dams were definitely breached, and the Sorpe damaged.		
	18.5.43		Today, the Air Officer Commanding No.5 Group addressed all personnel of this Squadron. After his address, all aircrew proceeded on 7 days leave, and ground crew, with the exception of a few personnel remaining as a skeleton staff, were given 3 days.		
			P/O. NEWMAN R.A. 117476 reposted to Squadron on appointment to commission.		
			P/O. C.A. DEERING 117245 reposted to squadron on appointment to commission.		
			P/Lt. J.J. MALTEY (60135) [REDACTED] D.F.C., CD. granted acting rank of Squadron Leader [REDACTED].		
	19.5.43		568102 SGT. DEWHAM R.B. Fit/Arm. posted to No.1, A.A.S.		
	20.5.43		1539602 SGT. WILLIAMS A. A/G. ceased attachment to A.C.R.3. Brighton.		
			P/L. ALLSEBROOK AND CREW. posted to Squadron.		
	21.5.43		His Majesty the King approved the following immediate Awards for the squadron operation on the German Dams. :- VICTORIA CROSS. WING COMMANDER C.P. GIBSON D.S.O. [REDACTED], D.F.C. [REDACTED].		
			C.O.M. P/SGT. K.W. BROWN. P/SGT. W.O. TOWNSEND. D.S.O. P/L. D.J. SHANNON D.F.C.,		
			P/Lt. J.C. MCCARTHY DFC. P/O. L.G. KNIGHT. S/LDR D.J. MALTEY DFC.,		
			P/Lt. H.B. MARTIN DFC. BAR TO D.F.C. P/O. D.E. WALKER DFC. P/L.R.E.F. HUTCHISON DFC		
			P/L. J.F. LEGG DFC. P/L. R.C. HAY DFC. D.F.C. P/O. L. CHAMBERS.		
			P/O. C.L. HOWARD. P/O. C.A. DEERING. P/O. H.T. TARRUM. P/O. F.M. STAFFORD. D.F.M.		
			P/Lt. TREVOR-ROPER DFC. P/O. J. FORT. WO. H.S. HODDAY. P/O. E.C. JOHNSON		
			P/O. J. BUCKLEY. BAR TO D.F.M. SGT. C.E. FRANKLIN. DFM.		
			D.F.M. P/SGT. T.D. SIMPSON. P/SGT. L.J. SUMPTER. SGT. D.P. HALL. P/SGT. D.A. MOWAN.		
			SGT. S. GANJA. SGT. C.L. JOHNSON. P/SGT. C.A. CHAMBERS. SGT. V. NICHOLSON		

(*9905) WL 51379-1364 140M 1/41 T.S. 700

OKP
SECRET
(American CONFIDENTIAL)
20.5.43.

gab
R25

INTERPRETATION REPORT NO. K.S.85

Photographs taken by 542 Squadron.

SCOTTIES	SCALE	MEAN TIME OF PHOTOGRAPHY
D/517 13.5.43.	1/9,800	11.30 hours.
D/578 17.5.43.	1/9,800	09.00 hours.
D/599 19.5.43.	1/18,000	10.35 hours.

LOCALITY: SORPE DAM.

INTRODUCTION

The Immediate Interpretation Report K.1559 gave information on the effect of the attack by Bomber Command on the night of 16/17.5.43.

The present statement and attached diagrams will describe changes as far as seen on available cover.

CONDITIONS BEFORE ATTACK

Two turbines seem to be working as shown by disturbed water (tailraces) in the compensating basin. Very little if any water is going down the overflow weir.
(Photo D/517 No.5133)

CONDITIONS ON 17.5.43 approx 6 (and 8½) HOURS AFTER ATTACK

The crown of the dam appears damaged over about 200' of its length. The upstream parapet which is part of the concrete core and the downstream parapet have disappeared. The concrete core is visible over some distance and has apparently been exposed to a depth at which it is about 6' thick.

A raised roughly rectangular object (3 on plan) about double the height of the parapet measuring about 40 x 25 feet was on the crown of the dam, blocking the roadway at the point of greatest damage (1 on plan).

Discoloration of the down stream side of the earth-dam and on the road indicate that water was splashed over the dam, leaving a wet semicircle of about 200 feet radius at the time of photography. A 200' wide strip of white is seen going from the crown of the dam to the compensating basin (4 on plan) and this is probably due to earth, gravel and rubble having been deposited when, following the splash, water was flowing down the face of the dam.

The water in the compensating basin is discoloured by mud over 2/3rds of the area. A very slight flow of clear water appears to enter this basin at a point just N. of the power house. There are indication that this has not been taking place for very long.

Water is apparently going down the overflow weir at the E. end of the dam indicating that the water level is up to or near its maximum.

There is no sign of any of the turbines working.
(Photo D/578 No.5137)

CONDITIONS ON 19.5.43 APPROX 55 (& 57½) HOURS AFTER ATTACK

Photographs show two distinct cavities. (1 and 2 on plan). The deeper of the two has penetrated to the upstream side of the concrete core of the dam and this is exposed over a distance of about 35 feet down to almost water level (1)

/ A working platform...

ITEM 15**SORPE DAM DAMAGE REPORT**

Analysis of the post-operational reconnaissance photos indicates that water was splashed over the top of the wall, that the crest was damaged over 200 feet (61 metres) and the concrete core of the dam was exposed. On closer inspection, "two distinct cavities" are apparent, proving accurate Upkeep releases were made by the two attacking aircraft. However, the report notes that the structure was "not sufficiently damaged to cause complete destruction", and that there was evidence that repair work was already underway. The attached diagrams illustrate these conclusions.

SECRET

Page 2.

A working platform appears to have been formed by the removal of debris. The object on the crown of the dam appears to have been reduced in height and also is not as rectangular in shape as before.

No water appears to be going down the overflow weir, but one of the turbines is working.

The discoloration of the water in the compensating basin has disappeared. A patch of slight discoloration upstream of (1) may indicate that rubble and earth has been thrown into the lake in preparing the working platform.
(Photo D/599 No.4006)

SUMMARY

Photographic evidence suggests that there are two points where explosions have taken place. The structure of the dam was not sufficiently damaged to cause complete destruction, and the latest photograph shows what may be work in progress on some sort of repair to the concrete core.

C.I.U. Plans No. 2 and 3 distributed.

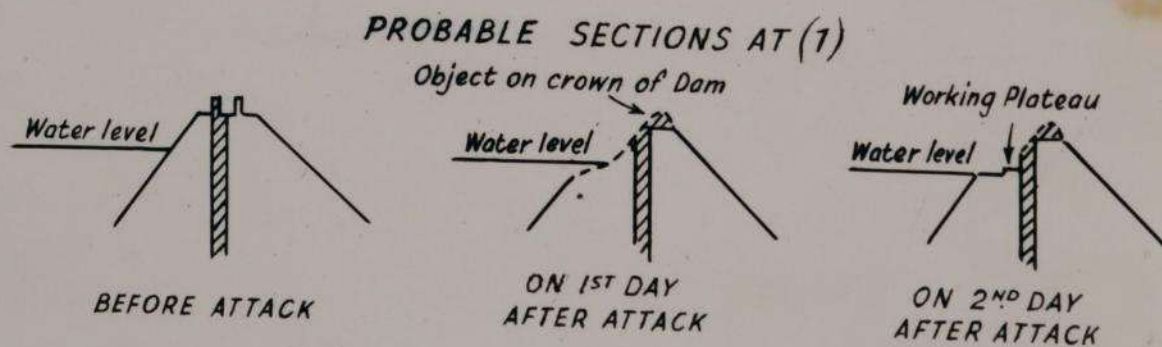
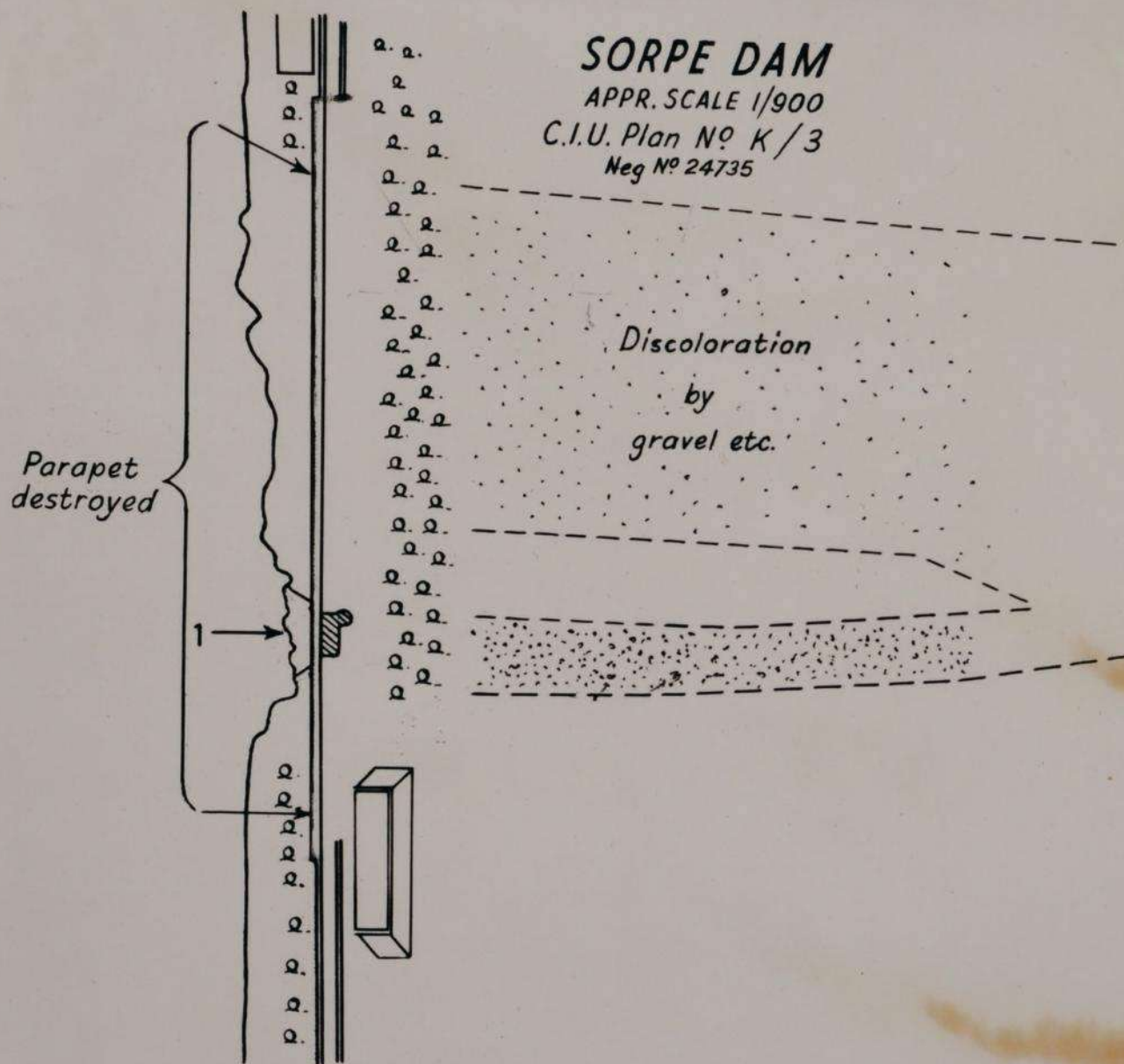
SECRET

R.A.F. STATION;

MEDMENE.MDAS/ME/CDISTRIBUTION No.25

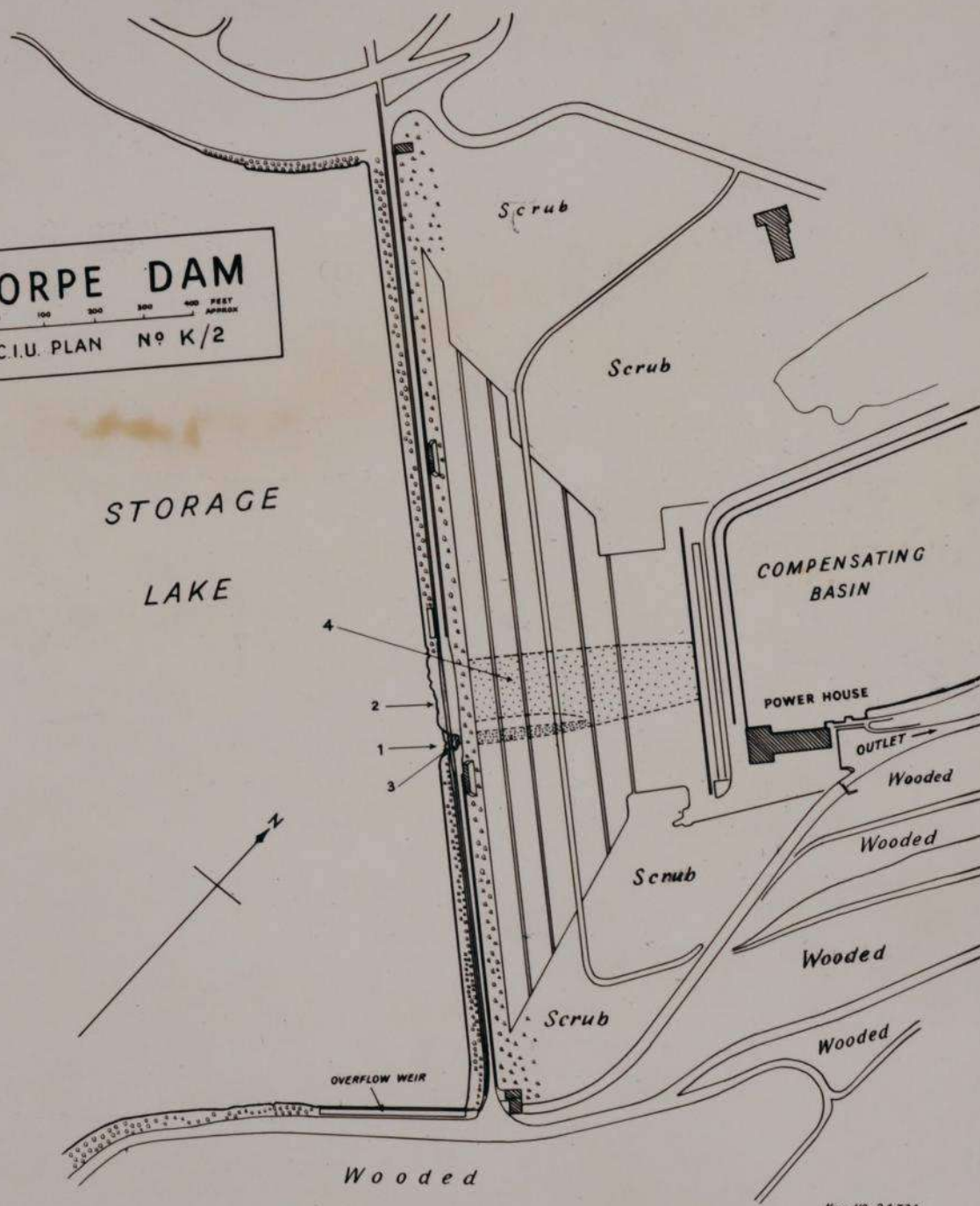
/ A.D.I.Ph	7
/ S.S. of S	1
E :	41
I :	8
M :	8

57 copies.



SORPE DAM
0 100 200 300 400 FEET APPROX
C.I.U. PLAN No K/2

STORAGE
LAKE

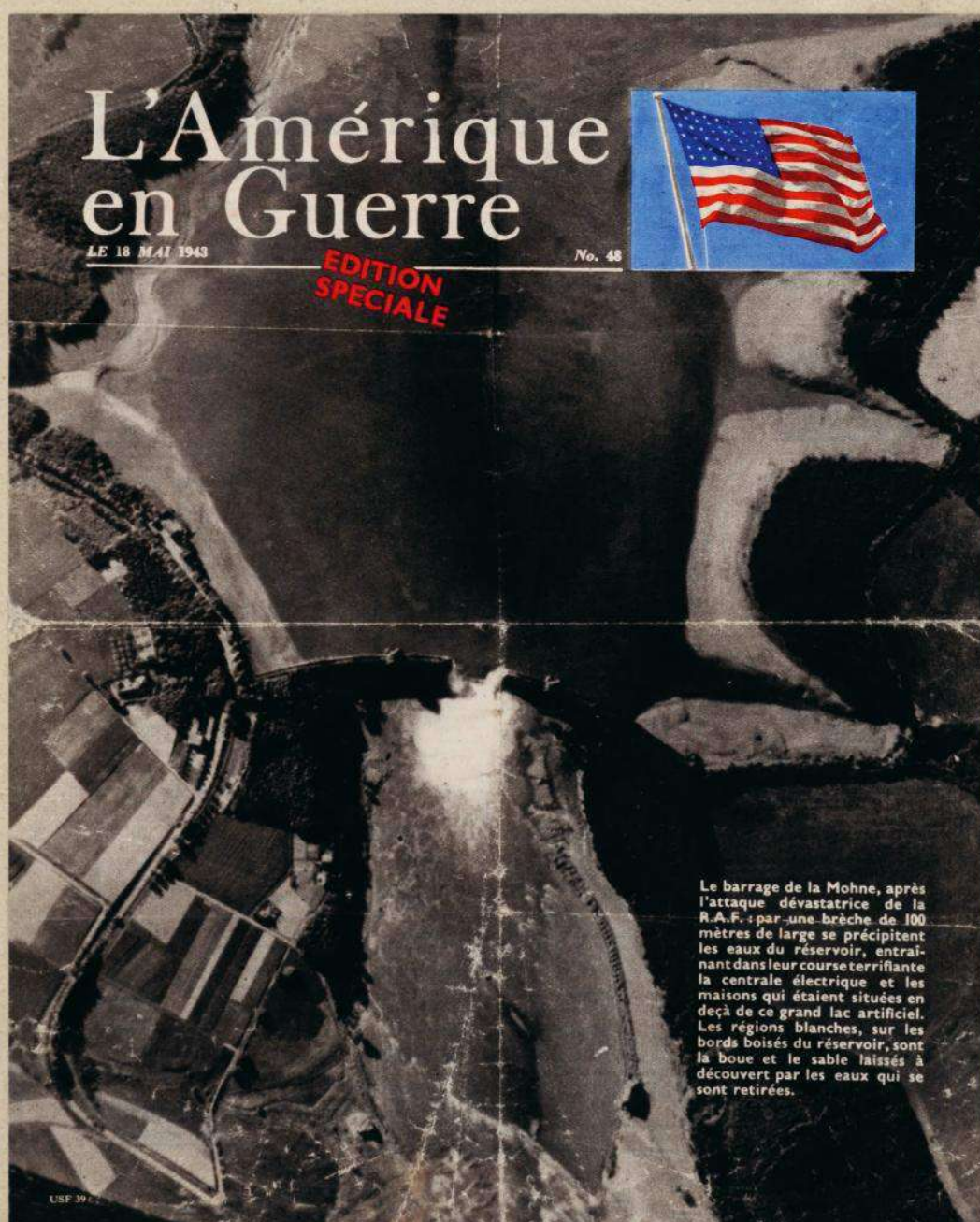


Map No 24734

ITEM 16

AMERICAN PAMPHLET

On 18 May a special edition of *L'Amérique en Guerre* was produced to be dropped on occupied France. The leaflet announces the "devastating attack by the RAF" which caused a "breach of 100 metres, through which water flowed to expose the mud and sand along the banks of the reservoir...Ruhr factories flooded...and below the Eder disruption had also occurred". It then goes on to say that "the attacks were carried out at very low level with extreme courage and coolness in spite of vigorous resistance." Details of the breaches are explained, the observations of participants quoted and a map provided to pinpoint the Möhne, Eder and Sorpe dams.



Les flots submergent les usines de la Ruhr, la R.A.F. ayant détruit deux barrages géants



Le lieutenant-colonel Gibson

Londres, 18 mai.—La nuit dernière, des bombardiers britanniques ont détruit 2 grands barrages sur les rivières Mohne et Eder, dans la Ruhr, au cours d'un raid audacieux. Audacieux, certes, mais aussi projeté et exécuté avec soin, car cette opération pourra bien avoir infligé à l'Allemagne industrielle son plus grand désastre de la guerre.

La formation de bombardiers Lancasters portait des mines puissantes et les équipages étaient composés d'hommes spécialement entraînés pour cette opération en particulier.

D'énormes brèches ouvertes dans les barrages ont occasionné une inondation gigantesque de plus de 3.000.000.000 de mètres cubes d'eau qui ont déferlé dans les vallées de la Ruhr et de l'Eder et qui priveront probablement cette région industrielle vitale de l'Allemagne d'eau et d'électricité.

Dans leur ruée hors des réservoirs, les eaux de l'inondation ont détruit des ponts, des usines, des centrales électriques et des lignes de communication.

L'inondation qui a résulté des dégâts causés au barrage de l'Eder est encore plus importante que celle de la vallée de la Ruhr, mais le pays est moins accidenté dans cette région et l'eau se répand sur une plus grande superficie.

Le Ministère de l'Air britannique a publié le communiqué suivant:

"Dans les premières heures de la matinée, un groupe de bombardiers Lancaster, commandé par le lieutenant-colonel G. P. Gibson, a attaqué au moyen de mines les barrages-réservoirs de la Mohne et de la Sorpe, qui commandent les deux tiers de la capacité d'emménagement d'eau du bassin de la Ruhr.

"Plus tard, des avions de reconnaissance ont constaté qu'une brèche d'une centaine de mètres de long avait été faite dans le barrage de la Mohne et que la centrale électrique établie en aval avait été emportée par le flot qui s'était déversé par la brèche.

"Le barrage de l'Eder, qui commande les eaux d'alimentation des vallées de la Weser et de la Fulda et actionne plusieurs centrales électriques, a également été attaqué et une brèche y a été signalée.

"Les photographies montrent que la rivière en aval de la digue a complètement débordé.

"Les attaques furent opérées à très basse altitude, avec grand courage et sang froid, malgré une violente résistance. Huit des Lancasters ne sont pas rentrés à leur base."

Le barrage de l'Eder se trouve à 40 kilomètres de Kassel. Sa longueur est de 400 mètres, sa hauteur de 41 mètres. La superficie du réservoir est de près de 12 kilomètres carrés. Le barrage de la Mohne se trouve à 70 kilomètres en amont de Dortmund. Il a 604 mètres de long et 41 mètres de hauteur. Les barrages-réservoirs de la Mohne et de la Sorpe commandent environ 70% de la capacité d'emménagement d'eau du bassin de la Ruhr. Avant leur construction, le bassin de la Ruhr courait le risque permanent d'être à court d'eau pendant les périodes de sécheresse.

Les effets du raid peuvent être désastreux pour l'ensemble de l'économie, de l'industrie et de l'agriculture dans le bassin de la Ruhr.

Les équipages des bombardiers Lancasters choisis pour cette opération avaient passé des semaines dans un centre spécial d'entraînement. Ils ont travaillé dans le secret le plus absolu, complètement isolés du monde extérieur et du reste de leurs camarades. Une demi-douzaine de personnes seulement étaient au courant de l'opération sans précédent qu'ils préparaient.

Le lieutenant-colonel Gibson, qui dirigeait les opérations, mena sa formation à l'attaque sur le barrage de la Mohne. Après avoir lâché ses mines, il se mit à voler de haut en bas du réservoir pour attirer sur lui le feu des canons de la D.C.A. qui y sont situés, afin de permettre à ses camarades de placer leurs mines plus aisément qu'il ne l'avait fait lui-même. Le deuxième Lancaster vit une immense gerbe d'eau d'au moins cent mètres projetée en l'air par les explosifs de Gibson. Il lâcha sa charge. Ce ne fut que lorsque le quatrième Lancaster eut lancé sa mine que la brèche se fit dans le barrage. Un pilote relate: "J'ai vu le premier jet d'eau très nettement. La brèche était d'à peu près 50 mètres." Un membre de l'équipage d'un bombardier qui revenait de l'attaque simultanée contre le barrage de la Sorpe dit: "Il m'a été difficile de reconnaître le bon bout du réservoir, parce que la forme en avait déjà changé. Je voyais déjà une nouvelle rivière de 12 kms. de long en aval du barrage. L'eau déferlait en avant à grande vitesse."

Répétant les attaques pour compléter leur travail de destruction, chaque équipage a attaqué avec une audace et un entêtement extraordinaires. Les avions descendaient à 30 mètres de leur objectif. "Lorsque ce fut notre tour d'attaquer—dit un des pilotes—on voyait déjà le haut du mur s'écrouler. Nos explosifs projetèrent de l'eau et de la boue à une hauteur de 300 mètres."

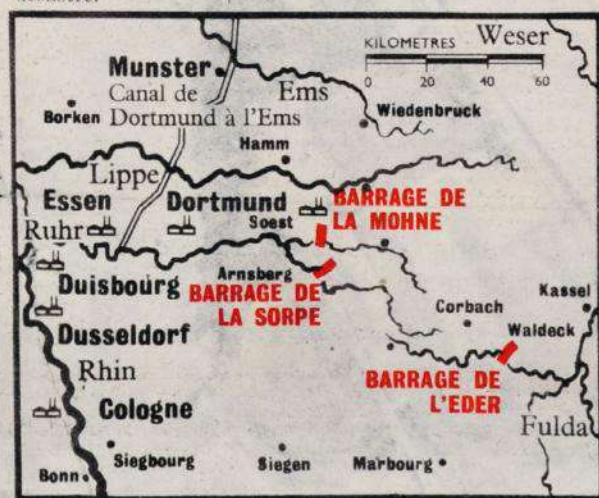
Le barrage de l'Eder a été percé de deux brèches de dix mètres à peu près. Des torrents d'eau s'en échappèrent et une vague de 10 mètres de haut commença à se précipiter dans la vallée.

Le maréchal de l'Air Sir Arthur Harris, commandant-en-chef de l'aviation de bombardement britannique attendait lui-même à l'aérodrome le retour des Lancasters. Le lieutenant-colonel Gibson lui dit en sautant de son avion: "Nous avions de grands espoirs, mais les effets immédiats des dégâts infligés aux barrages les ont tous dépassés."

Le maréchal de l'Air Sir Arthur Harris déclara par la suite, après avoir félicité tous ceux qui ont contribué au succès de cette entreprise:

"Je veux dire aux équipages que leur enthousiasme, la façon consciencieuse dont ils se sont entraînés, leur adresse et leur courage en livrant leurs attaques resteront pour toujours un exemple hors pair pour la R.A.F."

"Dans cette opération mémorable, ils ont remporté une victoire d'une importance primordiale dans la bataille de la Ruhr, victoire dont les effets se répercuteront jusqu'au jour où le dernier Allemand sera emporté par le flot du dernier désastre."



Publié par le Bureau d'Information de Guerre du Gouvernement des Etats-Unis d'Amérique à sa base européenne.

REFLECTION

Despite German resilience, the raid proved to be effective

Shortly after the last Lancaster landed at Scampton during the early hours of 17 May, administrative staff began to draft telegrams for the next-of-kin of 56 men. Letters, signed by Gibson, would follow, holding out hope that loved ones might have survived crashes, in which case notification would be received via the Red Cross. Only three such messages would arrive. Excluding three early returns, eight of the 16 aircraft (50 per cent) which attacked the dams had failed to make it back, "an awful lot" Sergeant D.P. Heal observed.

Intelligence sources soon discovered that the Germans had recovered Upkeep and the Air Ministry feared that the Heinkel He-177 or Dornier Do-217 might be adapted to launch a German version against British dams. Concern was intensified by an MP claiming that he had found "several vital dams" to be vulnerable: Loch Eicht in the Scottish Highlands, for example, was allegedly guarded by four policemen. On 26 May, the Chiefs of Staff's Anti-Aircraft Sub-Committee discussed deploying additional defences at 11 dams, including the Howden and Derwent dams, used during training by 617 Squadron crews and the Caban Coch in Wales (which had made the Nanty-Gro test dam redundant).

Although Loch Eicht was deemed too difficult to attack, on 10 June 12 other dams were considered vulnerable including "five Sheffield lakes". 5,000 men and women of 57 Anti-Aircraft Brigade were sent to protect them, together with anti-aircraft guns, searchlights and smokescreen apparatus, the latter intended to obscure the valleys in five minutes. Similar to measures taken in Germany, steel pylons were erected beside the reservoirs and cables strung low between them.

As time passed, the euphoria surrounding the Dams Raid was replaced by sharp criticism, not least because the breaches had been repaired so quickly. "Scant effect on German war production; the influence ... on the imponderable sum of war was negligible" represents this dismissive approach. Condemnation has been influenced by colourful and unjustified stories of the cataclysmic impact on Germany from the imaginative pens

of contemporary foreign correspondents, not more reasoned official analyses.

Nevertheless, Wallis was prompted to ask, "Was it worthwhile?"

If not cataclysmic, the results were far from "negligible". At the time, Goebbels wrote, "recent damage, except at the dams, has been relatively small", an interrogator told PoW Flight Sergeant Fraser that the operation had been a hundred times more effective than other raids, while Albert Speer dubbed the impact "critical". On 30 May 1943, Hitler emphasised to Speer the industrial importance of water supplies from reservoir dams. Post-war, Dr Walter Rohland and Dr-Ing Otto Kirschmer agreed that attacking the water supplies and transportation had merit. In the Ruhr, water supplies were restored only to a "tolerable" level and disruption to the waterways in the Weser valley was felt acutely. Specifically, water levels in the dams were never returned to their pre-raid levels with significant implications for industrial supplies. More broadly, Hans Rumpf (the responsible German official at the time) held that Operation Chastise had a particular impact on civilian morale, and the Luftwaffe general Adolf Galland similarly stressed its "lasting effect".



So concerned were German authorities in May 1943 that military commanders generally were ordered to guard any target, such as U-boat bases, "locks, moles etc", against "mine-bombs ... dropped in low-level flight" as in western Germany. Luftflotte (Air Fleet) 2 was instructed specially to protect 13 of the "most important dams in Upper Italy".

In Britain, Air Vice-Marshal Cochrane at 5 Group used 617 Squadron's achievement to urge main force crews towards greater accuracy: "Unfortunately a number of bombs are still falling 2, 3 and 5 miles from the aiming point, and this is delaying victory."

Hans Rumpf agreed that Operation Chastise involved "precision bombing of a high order".

SQUADRON SURVIVORS

One hundred and thirty-three men set out for the Dams, carried in 19 Lancasters each with seven men. Apart from three crews which returned without reaching their targets, eight crews came back and eight more were lost (53 men killed, with three becoming PoWs).

Two crews did not fly on the night, so on 18 May 617 Squadron comprised 13 crews, though Flight Sergeant C.T. Anderson's soon returned to 49 Squadron.

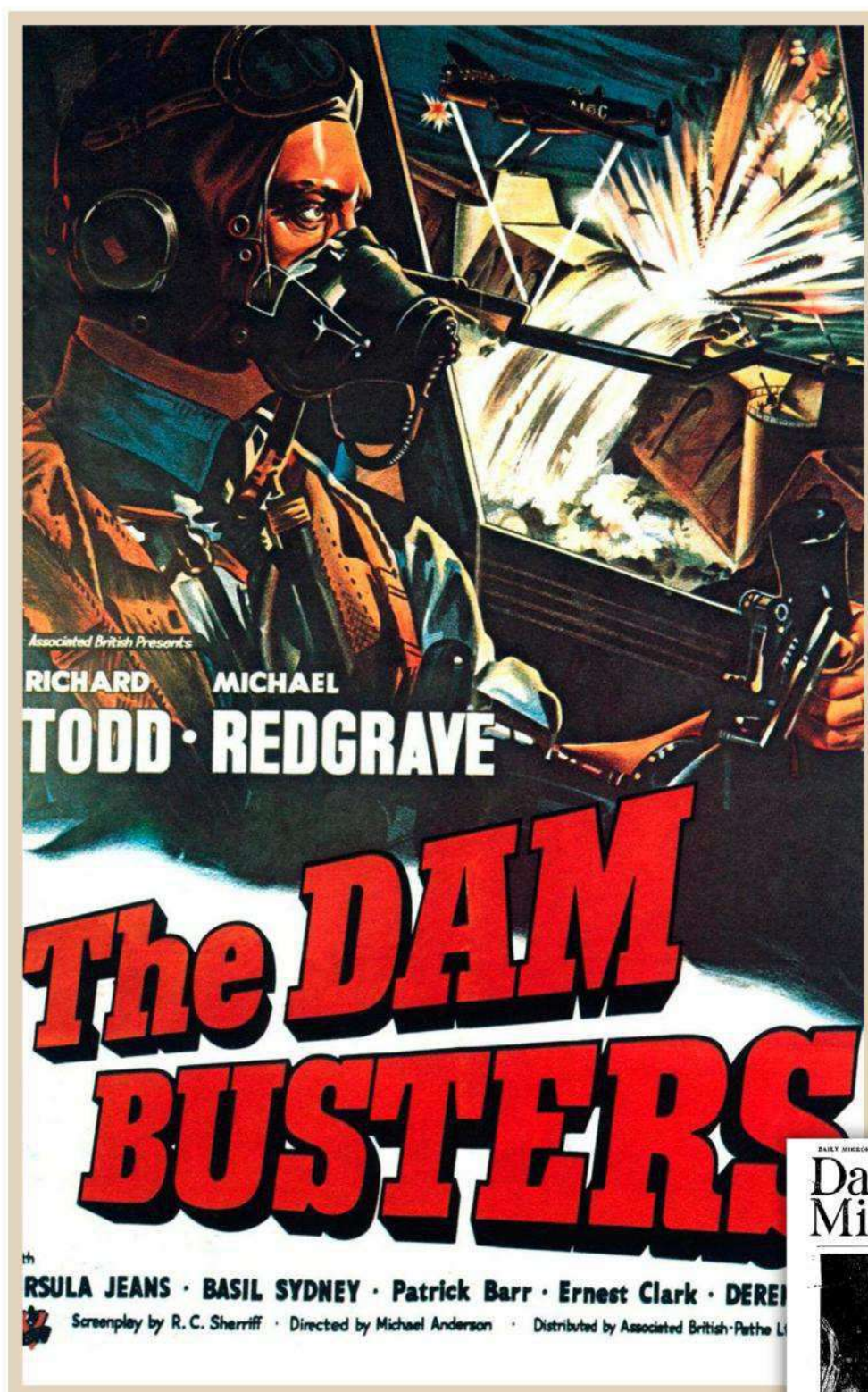
Operation Chastise was the only raid flown by the Squadron from Scampton (it then moved to RAF Coningsby). It was Wing Commander Gibson's only

operation with the Squadron. Within a matter of weeks, he had left to undertake a goodwill tour of Canada and the United States. Before Gibson left, a squadron photo was taken (below).

Gibson sits in the centre of the photograph, to his right are the Australian Flight Lieutenant Martin and the American Flight Lieutenant McCarthy; to his left is Squadron Leader Maltby, who learned on 18 May that he had been promoted. Gibson's replacement was Squadron Leader G. Holden DSO DFC, who was shot down on 15 September 1943 with four of Gibson's crew.



"WATER LEVELS IN THE DAMS WERE NEVER RETURNED TO THEIR PRE-RAID LEVELS WITH SIGNIFICANT IMPLICATIONS FOR INDUSTRIAL SUPPLIES"



"INTELLIGENCE SOURCES SOON DISCOVERED THAT THE GERMANS HAD RECOVERED UPKEEP AND THE AIR MINISTRY FEARED THAT THE HEINKEL HE-177 OR DORNIER DO-217 MIGHT BE ADAPTED TO LAUNCH A GERMAN VERSION AGAINST BRITISH DAMS"

PRESS COVERAGE

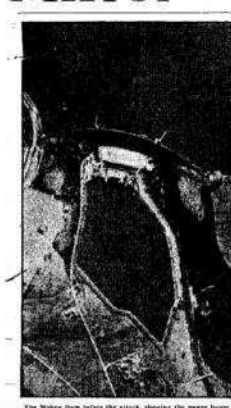
On 18 May, newspapers made full use of the before and after reconnaissance photos, as the *Daily Mirror* (below) demonstrates. The paper correctly reported that Gibson "flew up and down alongside the dam to draw the fire of the light anti-aircraft guns on it," but fancifully added that "guns were poking out of slots in the wall". The *Daily Mail* printed two diagrams of areas supposedly affected below the Möhne and Eder dams under the caption, "Devastated – by Water". The *Times* quoted anonymously "a flight lieutenant", "a pilot" and "a sergeant" concerning their experiences during the raid. Provincial newspapers like the *Lincolnshire Echo*, *Portsmouth Evening News* and *Exeter Express and Echo* elaborated the news. The *New York Times* covered the operation extensively and, from Moscow, *Reuter's* special correspondent cabled that the Dams Raid "was prominently reported in to-day's Russian newspapers". However, correspondents in Switzerland and Sweden began filing unrealistic stories. Allegedly 120,000 were homeless in the Upper Ruhr, rioting had occurred in Duisburg and Mülheim, Dortmund was "threatened by complete inundation", "All cities between Hannover and Karlsbad ... under water", a "state of siege proclaimed in whole of Westphalia", and the morale of people in Kassel was so low "their only desire is that the war should end". This gave the Germans ample opportunity to refute such fantasies and conceal the true impact.

Opposite-top: In January 1944, 617 Squadron moved from RAF Coningsby to RAF Woodhall Spa. The memorial in the nearby town is to all members lost during the Second World War

Opposite-bottom: Taken at RAF Scampton on 6 June 1943, a gathering of 617 Squadron with Wg Cdr G.P. Gibson VC DFC* DSO* flanked (his right) by Flt Lt H.B. Martin DSO DFC and (left) Sqd Ldr D.J.H. Maltby DSO DFC

Left: Poster for the film *The Dam Busters*, released in 1955. Despite containing errors of fact and concentrating on only two dams, it remains popular to this day

Daily Mirror



The Möhne Dam before the attack, showing the power house and the dam structure.

NAZI BLOCKADE-RUNNER BAGGED BY COUSIN OF THE QUEEN

THREE more enemy blockade-runners were taken down yesterday by the RAF's 'Dambusters' when they attacked the German coast near the Dutch border.

The RAF's 'Dambusters' were yesterday's heroes when they destroyed the Möhne Dam, the largest in the world.

The RAF's 'Dambusters' were yesterday's heroes when they destroyed the Möhne Dam, the largest in the world.

Pyjama death riddle

A YOUNG LAD, known as the 'Pyjama Man', was found dead yesterday in a room at the RAF's 'Dambusters' camp.

HUNS GET A FLOOD BLITZ



The Möhne Dam after the attack, showing the power house and the dam structure.

TORRENT RAGES ALONG RUHR

HUNDREDS of square miles of factories smashed to pieces

about 20 feet from the top of the dam, and the water was so high that it was impossible to see the top of the dam.

The water was so high that it was impossible to see the top of the dam.

WOMAN DOING MAN'S JOB

Thanks 'Yeast-Vite'

Dear Sir, I am writing to you to thank you for the 'Yeast-Vite' which I received from you last week. It has been a great help to me in my work.

OUR WIZARD BOFFIN

Squadron X and Barnes Wallis united again for more bombing successes

Air Chief Marshal Harris and Barnes Wallis were among those at 5 Group headquarters in Grantham listening to reports of Operation Chastise as it progressed. When it became clear that both the Möhne and Eder dams had been breached, the Commander-in-Chief Bomber Command famously turned to Wallis and assured him that, in future, he could sell him a pink elephant. The morning after the raid, Air Vice-Marshal Cochrane confirmed that Harris was interested in resurrecting the “big bomb”. Although, as Wallis ruefully noted, Upkeep achieved only “one wonderful feat”, his association with 617 Squadron was far from over.

Early in June, the possibility of dropping a 10-ton (22,400lb) bomb from a Lancaster at 20,000 feet (6,100 metres) was under consideration and by the end of the month it became Tallboy (L). Alongside, were proposals for smaller versions, the 12,000 lb (5,500kg) Tallboy (M) and 4,000 lb (1,800kg) Tallboy (S). However, focus centred on Tallboy (M), which became known simply as Tallboy.

In addition to burrowing beneath a target, direct hits on concrete structures like E-boat pens were contemplated, with penetration of five to eight feet (1.5 to 2.5 metres) being forecast. Accordingly, tests took place at the Road Research Laboratory, Harmondsworth, and dropping trials were carried out at Ashley Walk, near Fordingbridge, Dorset, and at the Orfordness Research Station in East Anglia.

By mid-1944, the “shining, blue and black steel, slim and perfectly streamlined” weapon

was ready; it was 21 feet (6.4 metres) long, with a pointed nose and long tail, and 38 inches (96.5 cm) in diameter at its widest. Three separate pistols were installed near the tail to activate 5,200 pounds (2,350kg) of Torpex, with four offset fins to achieve stabilisation and high velocity after release.

During the night of 8–9 June 1944, 617 Squadron dropped Tallboy on the Saumur railway tunnel in France and subsequently employed it against other precision targets like V-weapon sites using the special SABS Mk IIA bomb sight. For four years, the RAF, Fleet Air Arm and Royal Navy had been attempting to destroy the German battleship Tirpitz, which in September 1944 was anchored in northern Norway. Tallboy seemed the ideal weapon to deal with it, so 617 Squadron was despatched to sink her, succeeding on 12 November 1944.

The squadron was not finished with a Barnes Wallis bomb, though. Tallboy (L), known as

Grand Slam, which had been conceived in 1940, was soon ready. It was 26 feet 6 inches (8.1 metres) long, 3 feet 10 inches (1.15 metres) at its widest, 22,000lbs (10,000kg) in weight and contained 9,140lbs (4,145kg) of Torpex explosive. With Grand Slam, on 14 March 1945, Squadron Leader C.C. Calder demolished the Bielefeld railway viaduct.

After the release of the commercial film *The Dam Busters* in 1955, Air Marshal Sir Robert Saundby wrote that Barnes Wallis “did not originate the idea”, which had formed in 1938. But without Wallis, there would have been no Upkeep, no Operation Chastise, no 617 Squadron; and neither Tallboy nor Grand Slam would be there. At Sir Barnes’s ninetieth birthday party, held at East Horsley near his Effingham home – attended by former Squadron members from across the world and Air Chief Marshal Sir Ralph Cochrane (who rose from his sick bed to be there) – his wife



referred to 617 Squadron as “his baby”, and Marshal of the Royal Air Force Sir Arthur Harris described Wallis as “our wizard boffin”.

Opposite-right: Flight Officer Martin of 617 Squadron en route to attack the Arnsberg Viaduct on 19 March 1945 with Grand Slam. Note the Lancaster has neither a mid-upper turret nor bomb-bay doors

Opposite-bottom-left: On 14 March 1945, during a daylight raid, Squadron Leader C.C. “Jock” Calder dropped the first Grand Slam on the Bielefeld railway viaduct

Opposite-bottom-right: Grand Slam being manoeuvred onto a bomb trolley at RAF Woodhall Spa prior to the 617 Squadron attack on Nienburg railway bridge, 22 March 1944

Bottom: A deep hole made by a Grand Slam in the reinforced roof of submarine pens at Farge, near Bremen, dropped by 617 Squadron on 27 March 1945

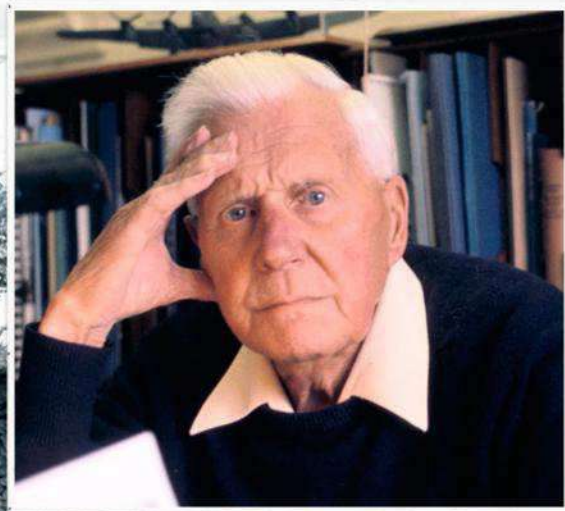
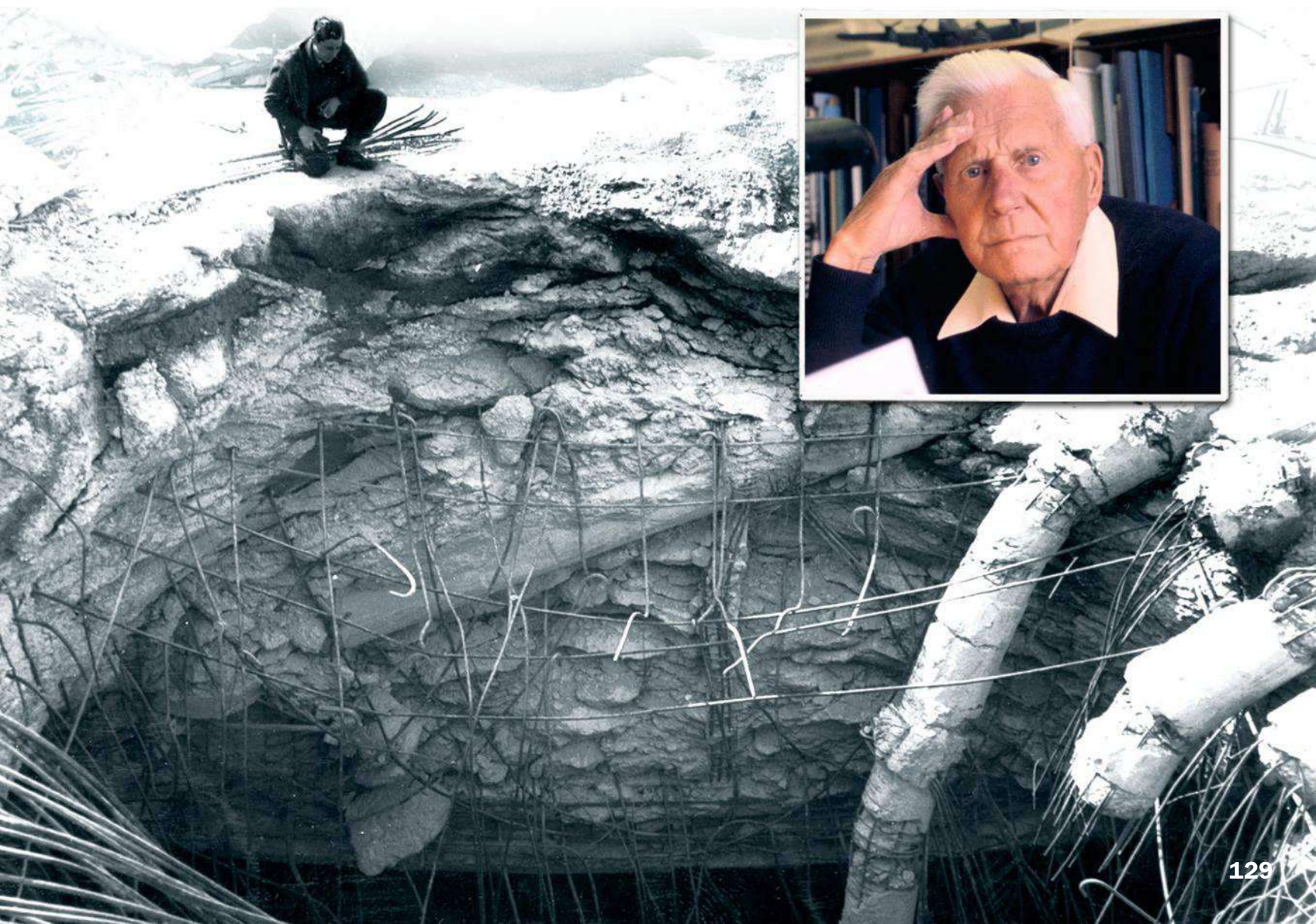
Bottom-right: Barnes Wallis in his study at his home in Effingham, near Guildford, where he continued research after his formal retirement in 1971

Right: Flight Officer J. Sanders (third right) and his crew after the successful operation to sink the German battleship Tirpitz near Tromsø in Norway, 12 November 1944

TIRPITZ

Since January 1942, the German battleship Tirpitz had been lurking in different Norwegian harbours threatening to break into the Atlantic, like her sister ship Bismarck, or attack the convoys carrying supplies to Soviet Russia along the Arctic route. Displacing 52,600 tons fully laden, Tirpitz was 828 feet (250.5 metres) long and 119 feet (36 metres) wide. Armour protected her sides, deck, internal magazines and crucial machinery. Apart from a vast array of anti-aircraft guns, deck mountings for eight torpedoes and provision for four reconnaissance seaplanes, the battleship was armed with eight 15-inch (38cm) guns able to range 22.4 miles (36,200 metres), and 12 5.9 inch (15cm) guns with 14.2 miles (23,000 metres) range. Capable of 34 knots (63 kph) in short bursts, German writers dubbed Tirpitz “a behemoth”. Winston Churchill called it “the beast”. To deal with Tirpitz should she emerge, a strong fleet of battleships, aircraft carriers, cruisers and destroyers was based on Scapa Flow, warships that could have made a positive contribution elsewhere. Between January 1942 and August 1944, RAF and Fleet Air Arm aircraft attacked Tirpitz on 11 occasions and the Royal Navy sent human torpedoes and mini-submarines in an attempt to sink her. It was then the turn of 617

Squadron armed with Barnes Wallis’s Tallboy. They flew to Yagodnik, a Soviet airfield near Archangel, and then, on 15 September, during a round flight to Kaa Fjord in northern Norway, a Tallboy badly damaged the starboard bow of the battleship. This was unknown in Britain and, when Tirpitz was brought south to Tromsø in range of Scottish airfields, another attack was launched on 29 October with no obvious success. On 12 November, the Lancasters struck again. Two Tallboys penetrated the armoured deck and another fell nearby. On 16 November, a signal was sent to German forces: “Our Tirpitz sunk”.





617 SQUADRON

DAMBU

The RAF's legendary bombing unit is not just renowned for the heroism of Guy Gibson's famous raid, but has also sunk a fearsome battleship, protected Britain from nuclear conflict and fought in the Iraq War

"SUCH AN OPERATION HAD NEVER BEEN ATTEMPTED BEFORE AND A NEW FORCE HAD BEEN ASSEMBLED SPECIFICALLY FOR THE TASK ON 21 MARCH 1943: 617 SQUADRON. ITS FIRST DARING OPERATION WOULD FLY IT INTO THE HISTORY BOOKS"



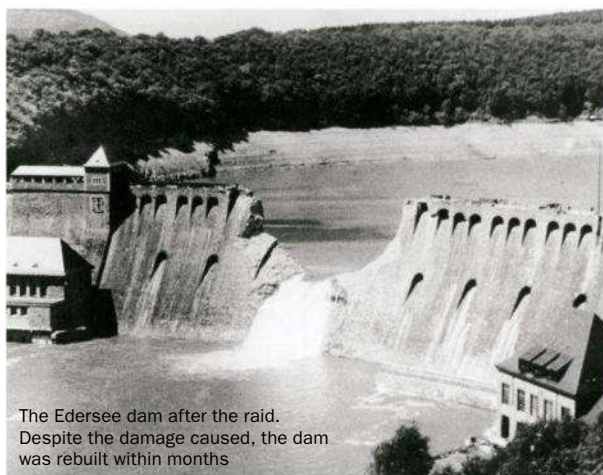
DAMBUSTERS AND BEYOND

WORDS TOM GARNER WITH THANKS TO DR ROBERT OWEN

The Möhne dam was breached by two of the Dambusters' bouncing bombs



Air Vice-Marshal Ralph Cochrane, Group Captain John Whitworth and Guy Gibson discuss the raid with King George VI



The Edersee dam after the raid. Despite the damage caused, the dam was rebuilt within months



A Grand Slam bomb explodes near the Arnberg viaduct. This raid, carried out on 19 March used an additional 5 Grand Slam and 13 Tallboy bombs

At 9.28pm on 16 May 1943, 19 Avro Lancaster Bombers took off from RAF Scampton in Lincolnshire at twilight under the utmost secrecy. Their mission was to deliver a unique weapon that would breach the walls of major dams in Germany's industrial heartland, causing major disruption. Until this night, there had been no bombs capable of such a cunning attack, but an innovative aeronautical engineer named Barnes Wallis had developed 'Upkeep', a remarkable weapon that could bounce on water, avoid torpedo nets and then detonate below the surface against the walls of a dam. Such an operation had never been attempted before and a new force had been assembled specifically for the task on 21 March 1943: 617 Squadron. Its first daring operation would fly it into the history books.

Although this elite unit of the Royal Air Force is known in history as the 'Dambusters', it went on to achieve other aerial feats of arms for the duration of World War II and beyond. Its operational service includes important roles in the sinking of German naval forces, ingenious diversionary tactics during the Normandy landings, acting as an effective deterrent during the Cold War and carrying out complex missile attacks during the invasion of Iraq. At all times during the squadron's active service, it was equipped with cutting-edge military technology and, while it is currently disbanded, it is in the process of reforming for 2018 when it will reassert its role as a major frontline player for the Royal Air Force.

D-DAY DECEPTION

On its very first mission, 617 had literally exploded into legend, a feat not equalled before or since by any other fighting squadron. Its prominence was now assured and the unit was retained to continue performing highly specialised attacks, many of which employed huge bombs designed by Barnes Wallis. At first, 617 attempted to bomb the Dortmund-Ems Canal at low level in September 1943 but five aircraft were lost and the commanding officer who replaced Guy Gibson was killed. Such missions were not repeated afterwards and 617 concentrated on high-altitude precision bombing, which was essential for the use of Wallis's six-ton 'Tallboy' and ten-ton 'Grand Slam' deep-penetration, earthquake bombs.

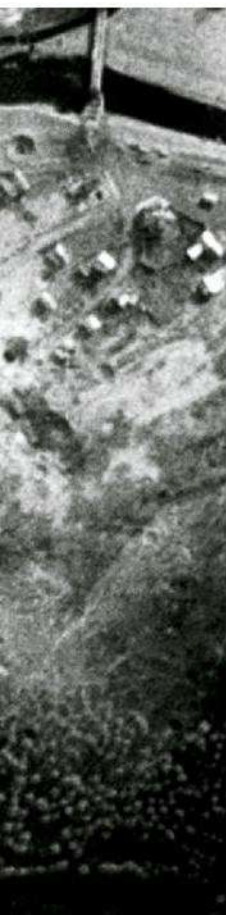
In the run-up to D-Day, 617 attacked factories, V-weapon sites and communications targets in France. The commanding officer, Wing Commander Leonard Cheshire, pioneered a new low-level marking technique that aimed to improve accuracy and minimise civilian

casualties when attacking targets in occupied territory. This was a novel concept but 617 also used deception tactics prominently displayed on D-Day itself. The Germans were aware that a continental invasion was imminent but they could not be certain of its location. For the Allies, it was impossible to hide the huge force prepared for Operation Overlord, but they worked hard to keep the Germans guessing where the invasion would take place. The Royal Navy and RAF carried out various diversions that did not involve the landing of troops but would be carried out at the same time as the actual landings.

As part of this huge deception, 617 was involved in Operation Taxable, an elaborate radar countermeasure. 617's task was to drop strips of metal foil known as 'chaff', which would interfere with German radar signals. They would be dropping chaff and co-operating with the Royal Navy to represent an invasion convoy approaching Antifer, north of Le Havre. Chaff was developed during World War II, and when it was picked up by radar, it either appeared as a cluster of primary targets or swamped the screen with swarming returns. 617's role in Operation Taxable was one of several similar missions carried out by the RAF for D-Day that involved both chaff (Operation Glimmer) and other deceptions, such as dummy parachute drops and motor launches (Operations Titanic and Mandrel).

The RAF flew meticulous missions to deliver a constant stream of chaff, simulating a large naval force crossing the English Channel. These missions aimed to convince the

"ON THIS OCCASION, THEY WOULD HAVE TO FLY AT 150 FEET (AND IN SOME PLACES 60 FEET), OVER WATER AND AT NIGHT. STATISTICALLY, THE ODDS WERE UNFAVOURABLE"



Wing Commander Guy Gibson VC (far left) with fellow members of 617 Squadron at RAF Scampton. Operation Chastise turned Gibson into a celebrity and the raid gave the British a significant morale boost

Left, top: Smoke rises from a near miss on the Schildescher Viadukt. It would take four months and multiple raids to finally collapse the target

Left, middle: A 617 Lancaster dropping a 'Grand Slam' bomb on the Arnberg viaduct in Germany, 1945. These huge bombs were another imaginative creation of Barnes Wallis

Left, bottom: The Möhne dam after it had been bombed by 617 Squadron. This photograph was discovered in German archives after the war

Germans that there were more, larger invasions taking place further up the French coast, even as the first sightings of the Normandy landings were received.

The planned execution of Taxable was meticulous. Bombers would fly a racecourse pattern at right angles to the enemy coast, beginning at opposite ends and chasing each other around in a circuit lasting ten minutes, while constantly dropping chaff. As well as gradually moving the pattern closer to the coast, the crews also had to adjust to the changing wind direction. This was a very challenging task and it had to be painstakingly timed. The rectangular circuits were flown at 180 miles per hour, at 3,000 feet. The flights towards France lasted two minutes and 30 seconds while dropping heavy strips of chaff, and the ones flying away lasted two minutes and ten seconds with lighter chaff drops. The timings were calculated in order to move the radar signature across the Channel at the prescribed speed of seven knots, and there was a light system where the aircrew dispensed the chaff every five seconds.

As an elite bombing unit, 617 was ideally placed to carry out Taxable, and eight Lancasters were requested for their exacting accuracy. Instead of the usual seven crew per aircraft, each aircraft had 12-13 men on board, including an additional pilot, navigator and extra manpower to help with dropping the chaff. At midnight on 6 June, the first eight Lancasters of 617 left RAF Scampton and flew tracks for two hours before being relieved by another eight planes. The second wave flew 500 feet above

"THE COMMANDING OFFICER, WING COMMANDER LEONARD CHESHIRE, PIONEERED A NEW LOW-LEVEL MARKING TECHNIQUE THAT AIMED TO IMPROVE ACCURACY AND MINIMISE CIVILIAN CASUALTIES"

the original aircraft on their final circuit and had just 90 seconds to switch over. If this failed, then the radar picture would have faltered and the Germans would have known they were being duped. Remarkably, 617 successfully carried out the mission even though they were flying at night with no lights or radio. This trickery was assisted by naval aids below, with ships and launches using electronic jamming and noise recordings to simulate large ships.

In terms of operational success, the deception missions varied. The Germans were mostly fooled by Operation Glimmer, which took place near the Pas-de-Calais. The German High Command issued an alert to expect landings near Calais and consequently 617's work in Normandy drew less attention.

Nonetheless, it can be said that their presence helped in the German High Command's unrelenting stubbornness to react to the real invasion.

SINKING THE TIRPITZ

For the rest of the war, 617 conducted bombing raids on various targets, including U-boat and E-boat pens, bridges, factories, railway tunnels and V-weapon sites. A high point of the use of 'Tallboy' was the destruction of Germany's last significant naval threat to the Allies: the Tirpitz.

Commissioned in 1941, the 42,000-ton Tirpitz was the sister battleship to the infamous Bismarck, which had sunk HMS Hood. Tirpitz carried a main armament of eight 15-inch guns and had seen limited action, spending most of its career in Norwegian waters, but its location meant that it was a constant threat to Allied convoys bound for Russia. Consequently, the Allies had to maintain a large fleet in northern waters, and there had been repeated attempts to sink it by the Royal Navy and RAF but none had succeeded. By September 1944, concerted efforts to sink Tirpitz resumed and this time, the RAF called upon 617 Squadron.

On 15 September, 27 Lancasters of 617 and Nine Squadrons flew from a Russian airfield to attack Tirpitz, which was anchoring in Kaafjord in northern Norway. 20 of these aircraft were carrying Tallboy bombs, and the mountainous terrain enabled the RAF to screen their approach from enemy radar. Consequently, the Tirpitz was caught by surprise. Some of the bombers were able to attack before its protective smokescreens were fully effective. One Tallboy broke through Tirpitz's forecastle and exploded in the water alongside – as a result its engines were damaged by the shock. All of the attacking Lancasters returned safely to Russia and the Germans decided that it

THE BOUNCING BOMB

Apart from the intrepid bravery of the airmen of 617 Squadron, Operation Chastise is also famous for the weapon used to breach the Ruhr dams: the bouncing bomb. Code named 'Upkeep', the explosives were the brainchild of Dr Barnes Wallis who worked for the engineering company Vickers Armstrong. In 1942, he began working on plans for a bomb that could skip across water, initially developing ideas by bouncing marbles across a water tub in his back garden. Wallis was given access to research bodies and carried out large scale experiments involving exploding charges against model dams and destroying a real 180 foot high disused dam in Wales. He concluded that breaching the dams would not be easy and aimed to create a bomb that would explode on contact with the dam wall. Meanwhile, he also had to persuade the sceptical authorities of the project's viability. He did not receive official approval until 26 February 1943. The timing was inconvenient because the best time to attack the dams was in spring when the reservoirs were full. Now Wallis had to design and produce the bombs in a very small time frame. He drew the first full-scale drawing of an Upkeep bomb on 27 February, only 11 weeks before the raid took place. There was also no modified aircraft available and so 617's training was improvised.

The bouncing bomb itself was a fusion between a depth charge and a mine that weighed 9,250

pounds. It contained 6,600 pounds of Torpex underwater explosive, along with three hydrostatic pistols, designed to detonate 30 feet below the surface. It measured less than five feet long and more than four feet in diameter and was held in the bomb bay of modified Lancaster bombers between twin-sprung callipers. The bay also contained a hydraulic motor that caused the bomb to backspin at a rate of 500rpm. This was to enable Upkeep to bounce across the water and avoid torpedo nets. When the bomb struck the dam wall, the backspin would cause it to stay in contact with the face of the dam as it sank. This would then focus the force of the explosion against the dam and would be sufficient enough to rupture the huge wall. On the night of 16 May, all of this complex science and engineering was still theoretical; it would take the skill of 617 Squadron to make Operation Chastise successful.



Top: An 'Upkeep' bouncing bomb attached to the bomb bay of Wing Commander Guy Gibson's Avro Lancaster during dropping trials at Manston, Kent in May 1943



Left and Above: An Avro Lancaster from 617 Squadron practices dropping a bouncing bomb at Reculver bombing range, Kent in May 1943

1 HIGH SPEED. LOW ALTITUDE. DANGEROUS

For the Möhne and Eder dams, the Lancaster's approach was 60 feet above the water, in the dark, flying at 220 miles per hour. However, the barometric altimeters cannot give an accurate reading. This is skilled but extremely hazardous work.

2 LIGHTS IN THE DARK

At this low altitude, pilots cannot read their instrument panels in case they crash. Instead, each Lancaster carries two spotlights that meet on the water's surface at 60 feet. The navigator calls "up" or "down" to the pilot.

3 PREPARING FOR DEPLOYMENT

Once the spotlights have converged, the Lancaster is now at a right angle to the dam. Before being released, the bomb is rotated at 500rpm by a hydraulic motor and belt drive.

4 BOMBS AWAY!

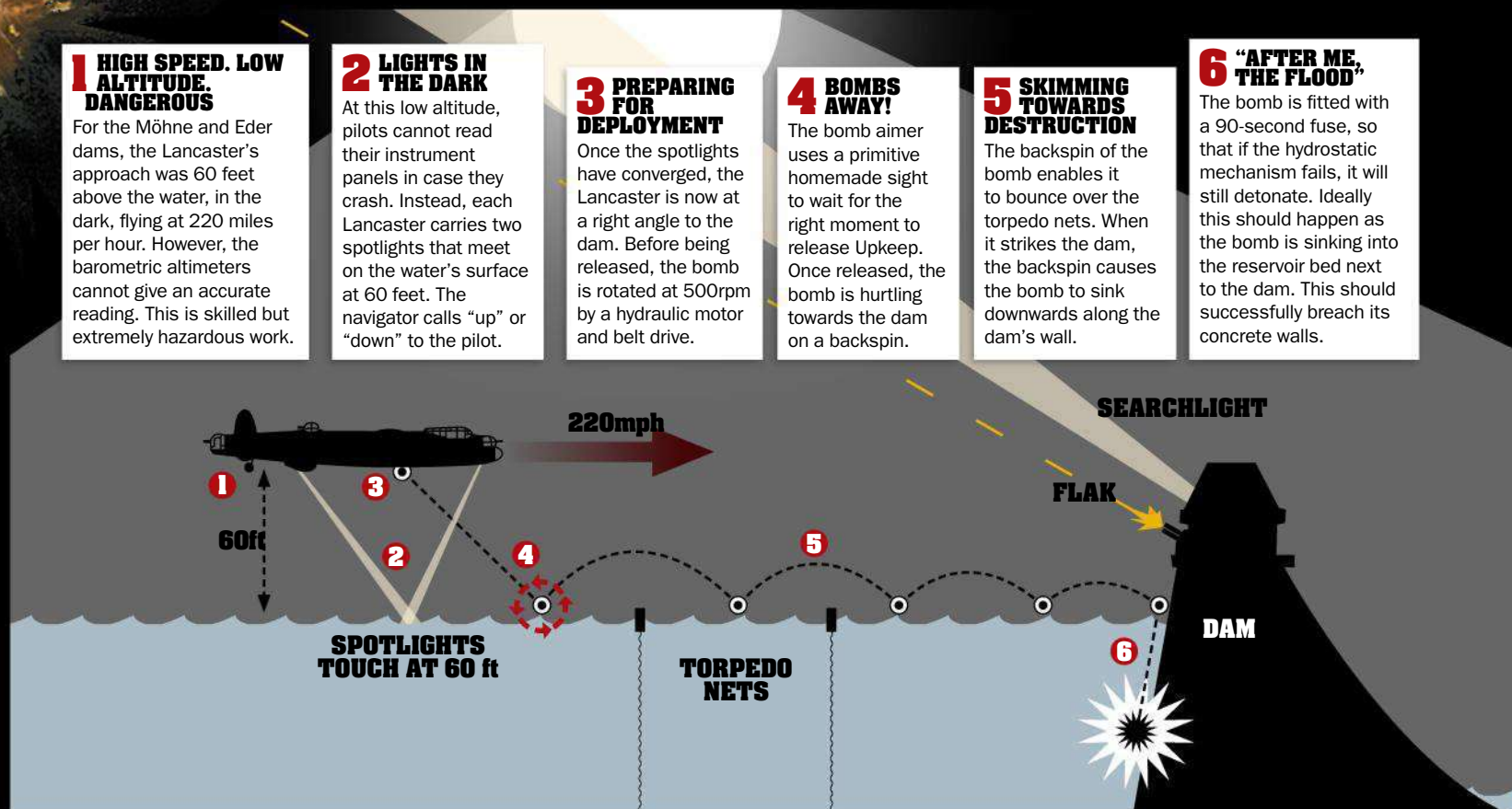
The bomb aimer uses a primitive homemade sight to wait for the right moment to release Upkeep. Once released, the bomb is hurtling towards the dam on a backspin.

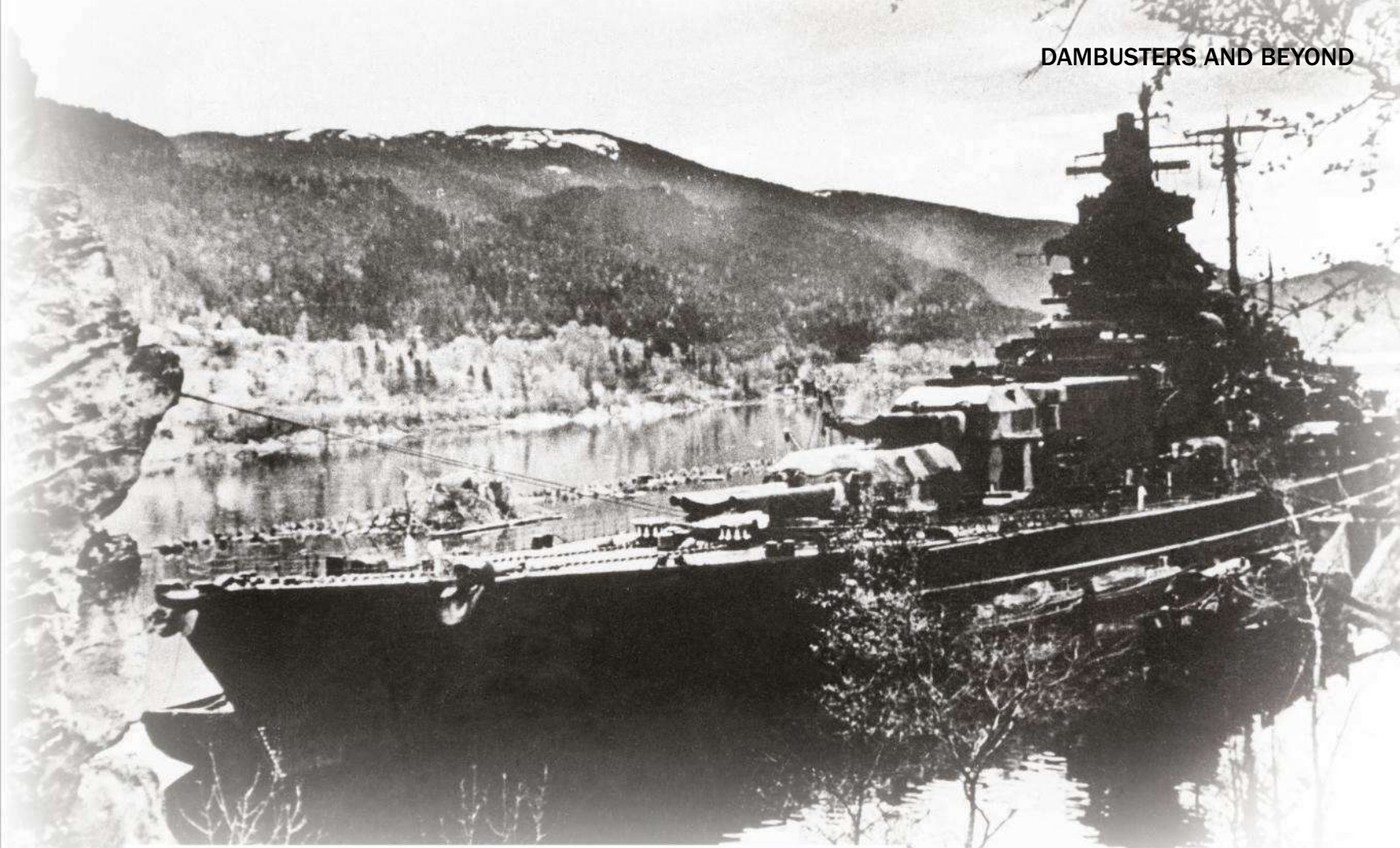
5 SKIMMING TOWARDS DESTRUCTION

The backspin of the bomb enables it to bounce over the torpedo nets. When it strikes the dam, the backspin causes the bomb to sink downwards along the dam's wall.

6 "AFTER ME, THE FLOOD"

The bomb is fitted with a 90-second fuse, so that if the hydrostatic mechanism fails, it will still detonate. Ideally this should happen as the bomb is sinking into the reservoir bed next to the dam. This should successfully breach its concrete walls.





Left: A 12,000-pound Tallboy bomb is hoisted to be loaded into a 617 Lancaster for a raid on a V-weapon site in France, 1944. Tallboy bombs also sunk the Tirpitz.




Above: Tirpitz was the pride of the German Navy during World War II; its fearsome reputation prompted Winston Churchill to dub it as 'The Beast'

was impractical to make Tirpitz fully seaworthy again, so it was moved south to Tromsø as a floating heavy artillery battery.

The RAF was unaware of Tirpitz's diminished role and continued to hunt it relentlessly, attacking it again on 29 October. 37 Lancasters flew from Scotland with their mid-upper gun turrets removed and extra fuel tanks installed. This meant that the Tirpitz could now be directly reached from Britain, even though it was a 2,250-mile operation. On this particular occasion, unexpected cloud cover prevented Tirpitz from being directly hit and the Germans installed fighters nearby after the attack. Nevertheless, the RAF was not to be deterred.

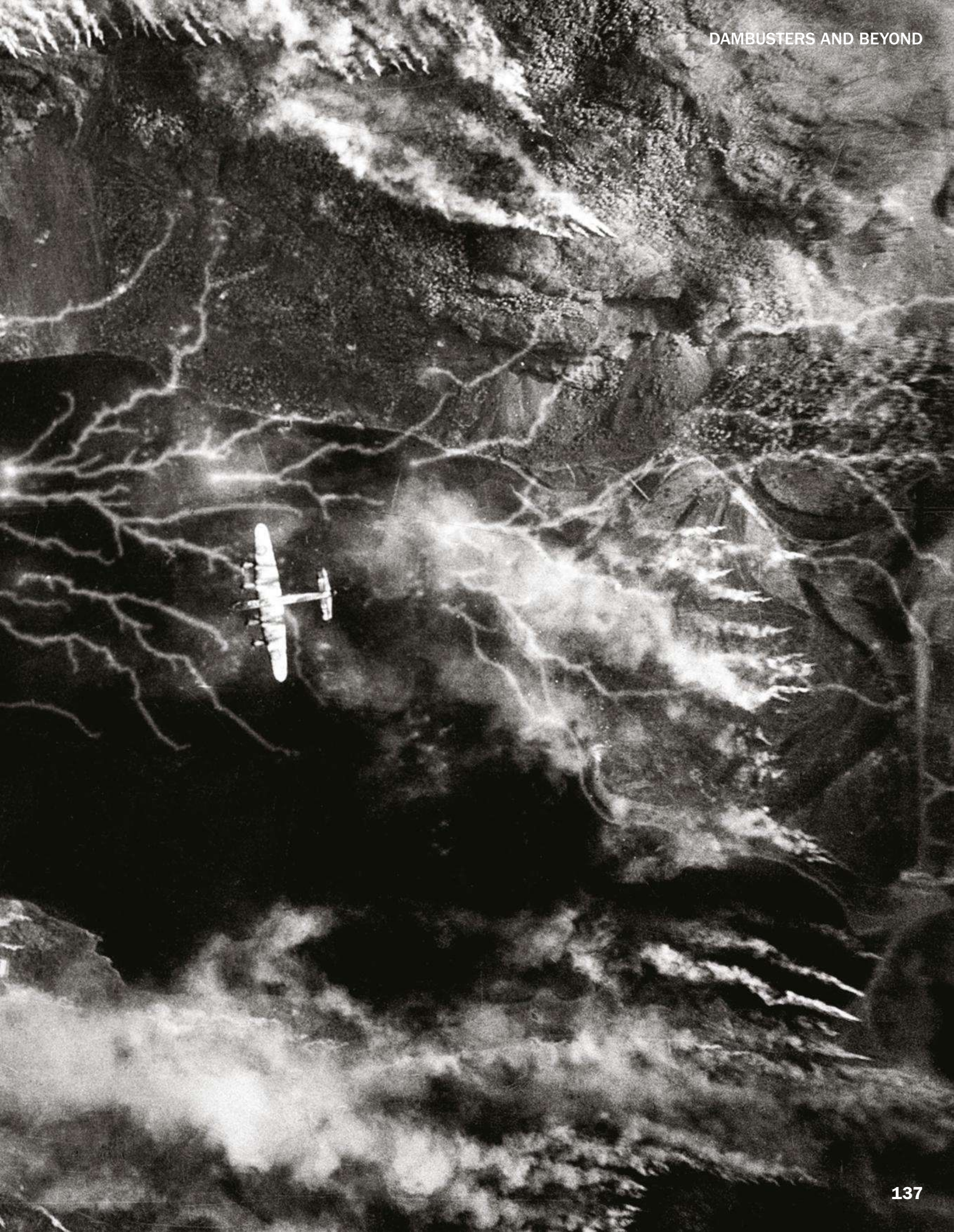
The final attack on Tirpitz happened on 12 November 1944. 29 Lancasters of 617 and 9 Squadrons once again took to the skies from Scotland and this time the weather was clear. They were led by 617 Wing Commander James

"BY SEPTEMBER 1944, CONCERTED EFFORTS TO SINK TIRPITZ RESUMED, AND THIS TIME, THE RAF CALLED UPON 617 SQUADRON"

An aerial black and white photograph of the German battleship Tirpitz in Norway. The ship is positioned in a narrow fjord, surrounded by steep, rocky cliffs. A large plume of white smoke or steam rises from the ship's deck, partially obscuring it. A red dashed circle is drawn around the ship's superstructure. The surrounding water is dark, and the sky is filled with wispy clouds.

A British air raid on the German battleship Tirpitz in Norway. This aerial shot shows Tirpitz (circled) setting off its smokescreen defences to confuse attacking bombers

“THE RAF HAD JUST CARRIED OUT ONE OF THE MOST SUCCESSFUL PRECISION BOMBING ATTACKS OF WORLD WAR II, WITH 617 AT THE FOREFRONT OF THE OPERATION”



617 SQUADRON IN THE HANGAR

617 HAS ALWAYS BEEN EQUIPPED WITH THE MOST TECHNOLOGICALLY ADVANCED AIRCRAFT

AVRO LANCASTER (1943-46)

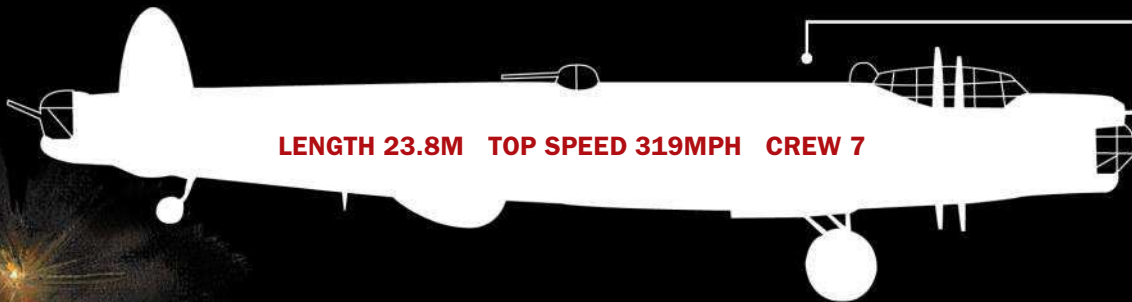
Considered to be the best British heavy bomber of World War II, the Lancaster could carry 14,000 pounds of conventional drop bombs and the massive 22,000-pound 'Grand Slam' bombs. With a crew of seven, eight Browning machine guns for self-defence and four Rolls-Royce Merlin engines, the Lancaster was a fearsome aircraft.



LENGTH 21.1M TOP SPEED 272MPH CREW 7

AVRO LINCOLN (1946-52)

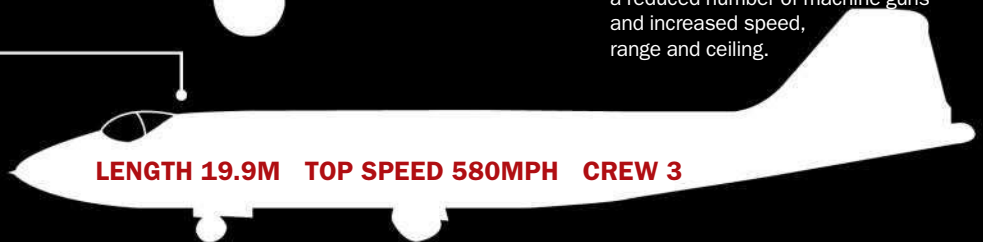
The Lincoln was Avro's post-war answer to the Lancaster, and outwardly appeared to be an enlarged version of its predecessor, with striking similarities including the same number of crew, engines and bomb capacity. However, it had a reduced number of machine guns and increased speed, range and ceiling.



LENGTH 23.8M TOP SPEED 319MPH CREW 7

ENGLISH ELECTRIC CANBERRA (1952-55)

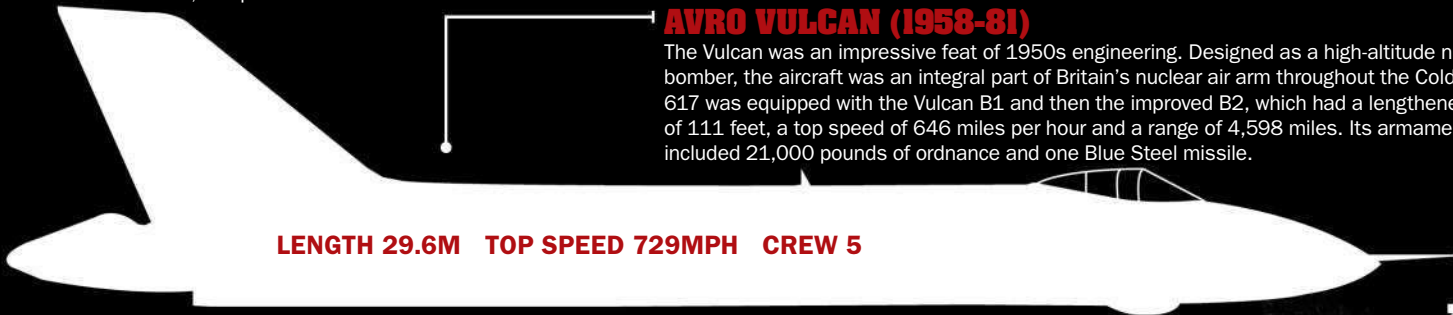
The Canberra was 617's first jet-powered aircraft and was a strike-minded medium bomber. Initially designed to replace the De Havilland Mosquito, it was a successful aircraft that stocked 61 RAF squadrons and had impressive specifications. It had a top speed of 580 miles per hour, which enabled it to outrun other contemporary jets and, with a crew of three, could carry ordnance of 8,000 pounds.



LENGTH 19.9M TOP SPEED 580MPH CREW 3

AVRO VULCAN (1958-81)

The Vulcan was an impressive feat of 1950s engineering. Designed as a high-altitude nuclear bomber, the aircraft was an integral part of Britain's nuclear air arm throughout the Cold War. 617 was equipped with the Vulcan B1 and then the improved B2, which had a lengthened wing of 111 feet, a top speed of 646 miles per hour and a range of 4,598 miles. Its armament included 21,000 pounds of ordnance and one Blue Steel missile.



LENGTH 29.6M TOP SPEED 729MPH CREW 5

PANAVIA TORNADO (1983-2014)

Tornados are a multirole aircraft capable of strike air support, counter-air attack, defence suppression, reconnaissance and long-range maritime attacks. 617 flew variants of the Tornado from 1983-2014 and often carried nuclear bombs, with each aircraft capable of carrying two. In 2013, 617's Tornado GR4s were decorated in special markings for the 70th anniversary of Operation Chastise.



LENGTH 16.7M TOP SPEED 1,490MPH CREW 2

LOCKHEED MARTIN F-35 LIGHTNING II (2018-)

In 2018, 617 Squadron will be the first operational RAF unit to receive the highly advanced F-35 Lightning II. The F-35 is the world's most advanced multirole fighter and its advanced stealth enables it to penetrate areas without being detected by radar. It can also take on all missions traditionally performed by specialised aircraft, such as air-to-air combat, air-to-ground strikes, electronic attack, intelligence, surveillance and reconnaissance.



LENGTH 15.7M TOP SPEED 1,200MPH CREW 1

These Vulcan bombers have anti-flash white colouring, designed to reflect thermal radiation

Tait. The bombers flew at 1,000 feet to avoid early detection by enemy radar prior to rendezvousing above a lake 100 miles south east of Tromsø. The squadrons then climbed to a bombing height of between 12,000-16,000 feet before sighting Tirpitz 20 miles away. This time the smoke screen was not working and even more curiously the recently installed fighters did not appear, despite desperate calls for air cover. Tirpitz had to make do with its own anti-aircraft guns, supporting fire from shore batteries and two flak ships, which began to fire when the bombers were 13 miles away.

The first Tallboys narrowly missed their target but they were then followed by three rapid direct hits, the first one being delivered by Tait himself. A column of smoke and steam rose up to 300 feet and within minutes the ship started to list. It then suffered a huge explosion as an ammunition magazine went up and Tirpitz rolled over to port and capsized about ten minutes after the first bomb struck. By now, the ship had rotated about 125 degrees and only the hull was visible from the air. Between 950-1,200 crew members were killed during the sinking and there were only approximately 200 survivors. By contrast, none of the attacking aircraft were significantly damaged and all but one returned safely, with one aircraft landing in neutral Sweden.

The RAF had just carried out one of the most successful precision bombing attacks of World War II, with 617 at the forefront of the operation. Winston Churchill had dubbed the Tirpitz 'The Beast' for its persistent resistance to being sunk, but now that it had been destroyed there was great relief across the country. The secretary of state for air, Sir Archibald Sinclair, paid a visit to the squadrons the day after the attack and congratulated them on sinking, "...one of the toughest ships in the world."

Nazi Germany had lost its last influential battleship, marking the end of the naval war in northern waters. It would also be the last high-profile raid of World War II for 617, but the squadron would continue to be at the forefront of RAF operations in the post-war period.

THE COLD WAR AND BEYOND

Following the end of World War II, 617's legendary Lancaster bombers were replaced by Avro Lincolns and then English Electric Canberras. On 15 December 1955, the squadron was disbanded but reformed shortly after on 1 May 1958 as part of Bomber Command's V-bomber force, which maintained Britain's strategic nuclear deterrent. 617 was equipped with the technically advanced Avro Vulcan B1 and B2 bombers and its assigned role was high-level strategic bombing with a varied armament of nuclear weapons.

Vulcan B2s (the squadron's key aircraft between 1961-81) could carry two nuclear weapons, but the delivery of free-fall bombs into the increasingly deadly defences of the USSR became a dangerous proposition. Consequently, 617's Vulcans were provided with Blue Steel missiles that could be fired

"617 WAS EQUIPPED WITH THE TECHNICALLY ADVANCED AVRO VULCAN B1 AND B2 BOMBERS AND ITS ASSIGNED ROLE WAS HIGH-LEVEL STRATEGIC BOMBING WITH A VARIED ARMAMENT OF NUCLEAR WEAPONS"



Avro Vulcan B2s of 617 Squadron at RAF Cottesmore in 1975. Vulcans were Britain's primary nuclear air deterrent for over 20 years

up to 100 miles away from the target. Upon launching, the missile rocket engines would fire, boosting it to high altitudes and allowing the Vulcan crew to turn for home, leaving Blue Steel to fly on towards the target independently. Blue

Steel remained the primary British nuclear deterrent until the introduction of the naval Polaris missiles. Vulcans were also equipped with WE177B nuclear free fall weapons. These had a yield of 400 kilotons, weighed 950 pounds and were 133 inches in length.

It was the longest serving British nuclear weapon, with a service lasting 32 years, but thankfully 617 never had to deploy Blue Steel or the WE177B in anger.

617 was again disbanded on 31 December 1981 but reformed in January 1983 equipped with Panavia Tornados, which the squadron would fly updated variants of until 2014. It was in Tornado GR4s that 617 once again flew into pioneering combat as part of the invasion of Iraq. On 21 March 2003, 60 years to the day since 617 Squadron was formed, the RAF deployed a new weapon in a combat scenario for the first time during Operation Telic: the Storm Shadow Missile.

Storm Shadow is a European, air-launched cruise missile equipped with a powerful, British-developed conventional warhead. It was designed to attack important targets and infrastructure such as buried or protected command centres. Mission and target data is loaded into the weapon's main computer before the aircraft leaves on its mission. After being released up to 75 miles from a target, the weapon's wings deploy and the missile

Left: The Operation Telic Campaign Medal for service in Iraq. 617 Squadron earned this medal for attacking Saddam Hussein's high command centres

Right: A Tornado OGR4 from 617 Squadron, fitted with Storm Shadow cruise missiles directly under the fuselage in 2004. The squadron used this weapon a year previously during the invasion of Iraq

navigates its way to the target at low level using terrain profile matching and an integrated GPS system. In 2003, each missile cost £750,000, and it was rushed into service so it could be ready for the invasion. Its deployment was so secret that it was moved around at nighttime. Tornado GR4s were ideal ground attack aircraft and 617 Squadron was chosen to carry out 'a historic mission'.

The squadron was based at Ali Al Salem in northern Kuwait and was ordered to use Storm Shadow to penetrate the heavily reinforced bases of Saddam Hussein's high command. Like the Dambusters before them, 617 would be using a new sophisticated bomb for the first time. The RAF detachment commander, Group Captain Simon Dobb, felt uneasy: "It was untried in an operational environment, and was a hearts-in-mouth operation for us because we had never flown with the real thing and had no idea how well it would work."

The Tornados took off with a full payload of Storm Shadows at the beginning of the aerial bombardment of Baghdad. Soon after crossing the Iraqi border, an aircraft flown by Squadron Leader 'Nobby' Knowles and Flight Lieutenant Andy Turk was locked on to by a surface-to-air missile and had to ditch its fuel tanks. Dobb recalled: "We were flying to targets north of Baghdad. Storm Shadows are heavy at 1,350 kilograms each and we used more fuel. Nobby and Andy were fuel critical so we let them in first

to fire their missiles and return home. Then, as we entered our attack run, we too came under missile attack. We were targeted by what I think was an Iraqi SA2 missile." Knowles and Turk had to take evasive action before continuing their mission. Dobb said of the mission: "We were operating in a high-threat environment. Looking back I can say I was nervous, and I was excited, not in a joyful sense, but because I knew we were making history."

Early assessments of the attack suggested that the Storm Shadow missiles had hit their intended targets with pinpoint accuracy. 60 years to the day that Wing Commander Guy Gibson had flown over Germany's dams with his 'bouncing bombs', 617 Squadron had once again proven its reputation.

Although 617 Squadron disbanded in 2014, it is currently in the process of being reformed. Equipped with the latest F-35 Lightning multirole stealth fighter, the squadron will once again take to the skies in January 2018 to continue its work as one of the most elite squadrons in the Royal Air Force.

Two Tornado GR4s of 617 Squadron pull away from a KC-135 Stratotanker after refuelling in 2006

"IT WAS IN TORNADO GR4S THAT 617 ONCE AGAIN FLEW INTO PIONEERING COMBAT AS PART OF THE INVASION OF IRAQ"

Images: Getty

MEET THE PILOT LAWRENCE 'BENNY' GOODMAN

ONE OF THE LAST SURVIVING BRITISH 617 SQUADRON PILOTS FROM WWII DESCRIBES HIS EXPERIENCES ATTACKING THE TIRPITZ, ENCOUNTERING GERMAN FIGHTER PLANES AND BOMBING HITLER'S ALPINE RETREAT

Born in 1920, Lawrence 'Benny' Goodman joined the RAF in 1940 and joined 617 Squadron in 1944 as a pilot with the rank of flight lieutenant. He took part in 30 operations with the squadron, attacking everything from U-boat and E-boat pens to viaducts, railway bridges, dams, battleships and even Hitler's infamous 'Eagle's Nest'. He left the RAF in 1964 as a squadron leader. Now in his mid-90s, he recalls his extraordinary flying experiences.

WHAT WAS YOUR ROLE IN ATTACKS ON THE TIRPITZ IN OCTOBER 1944?

It was rather small, from about 20,000 feet. As far as the pilot was concerned, the bomb aimer dictated your course. Once we had started the run in, he controlled you as he was focused on the target. He adjusted my course from his bombsight so that we could try to keep one or two degrees of the direction he wanted. My raid was the second attempt to sink the Tirpitz and it was rather cloudy. We had a great deal of trouble spotting the ship, big though it was. It was not only cloudy but the Germans put up a smoke screen. My bomb aimer finally saw it but the trip itself was called off. Although he dropped the bomb, I don't think it had much effect. We didn't encounter any fighters but we later learned that they had watched us going over the airfield, but they decided that we were transport or cargo planes from the Luftwaffe carrying supplies, so they didn't bother.

ON 12 JANUARY 1945, YOU WERE ATTACKED BY GERMAN FIGHTER PLANES WHILE DROPPING TALLBOY BOMBS ON SUBMARINE PENS AT BERGEN. WHAT ARE YOUR MEMORIES OF THAT EXPERIENCE?

We did come under fire sometimes and some trips, like Bergen, were bad. It was a daylight raid and we were after the ports there. We had a fighter escort but they went down to deal with the heavy flak. As they did, a mixed squadron of Focke-Wulf 190s and Me109s came up and played a little bit of havoc with us. Several of the squadron were shot down or damaged but we did bomb. When you're in the moment, quite a lot of things go through your mind. The main thing is, particularly as the pilot of the aircraft, you must keep cool and make sure everybody else does too,

but I never encountered any panic among the crew ever. Discipline was maintained because you were trained for that. We were pretty lucky.

HOW DID IT FEEL TO BE FOLLOWED BY A ME262?

When we bombed Hamburg on a daylight raid, about 10-20 minutes after we left the target we saw a Me262, which was the latest jet fighter. I'd never seen one before and I think very few of us had. I must say it was more than a surprise to have my flight engineer nudge me in the ribs and nod his head towards the starboard side. I didn't look the first time as I thought he was indicating the fuel gauges. He did it again more vigorously so I looked up and was amazed to see the latest German jet on our starboard wing. That didn't please me to say the least and several things went through my mind such as "What do I do?" We had an evasion tactic called the 'Five Group Corkscrew' but this aircraft was sitting by us and I'm sure his ability to corkscrew in the air as a fighter would have been far more than flying a bomber, so I dismissed that immediately. We had no mid-upper turret; he could see that, so he knew he wasn't going to be fired on. He just sat there for what felt like hours, but the flight engineer later told me it was just under a minute. There was no comradeship in the air, we didn't salute each other or wave. He was staring at us and we back at him, I was wondering what the hell to do of course. Fortunately, I don't know whether he ran out of ammunition or not but he had been firing at another aircraft of our squadron and hadn't hit that either. He was either a new pilot or new to the jet, but as far as we were concerned, it was a lucky escape.

WHAT WAS YOUR ROLE IN THE ATTACK ON HITLER'S MOUNTAIN RETREAT NEAR BERCHTESGADEN IN 1945?

We had no idea it was going to be the last operation of the war but I know that we certainly destroyed the SS barracks at Berchtesgaden. We were the first of eight aircraft to bomb, so anything could have happened behind us, but I don't think Berchtesgaden itself was damaged. Certainly the barracks were shattered as far as we could see. There was quite a lot of destruction, I don't quite know who hit it but I would never claim any individual success, we always did it as a squadron. It didn't feel symbolic at the time but we realised what it meant to Hitler and the German people having it bombed.

Below: An aerial photograph taken during 617 operations over Bergen harbour, Norway, circa 1940



Below: The Me262, nicknamed the Schwalbe or Swallow, was the world's first jet fighter



Below: Aerial photo taken during the raid on Hitler's chalet complex and the SS guard barracks near





70TH ANNIVERSARY

On 16 May 2013 to mark 70 years since the Dambusters raid, a Lancaster bomber flew over the Ladybower Reservoir in the Peak District, watched by veterans of the original campaign.



CREDITS

The publisher would like to thank the following people for their help with the production of this book:

Olivia Smales, Simon Gresswell and Matthew Glynn, IMG

Squadron Leader John McFall, Royal Air Force

Peter Elliott and Nina Hadaway, Royal Air Force Museum

Mary Hudson, Royal Air Force Historical Branch

Paul Johnson, The National Archives, Kew

PHOTOGRAPHS

The publishers would like to thank the following sources for their kind permission to reproduce the pictures in this book.

Key: l = left, r = right, c = centre, t = top & b = bottom

8 & 9. RAF Air Historical Branch, 14t. Getty Images/Hulton Archive, 14b. RAF Air Historical Branch, 15tl. 15tr & 15b. RAF Air Historical Branch, 16t. Getty Images/Hulton Archive, 16bl. RAF Air Historical Branch, 16r. Getty Images/Hulton Archive, 17t & 17b. RAF Air Historical Branch, 18t. Imperial War Museum, MH 31, 18b. RAF Air Historical Branch, 18c. AKG-Images/IAM, 19t & 19b. AKG-Images, 20t. Getty Images/Popperfoto, 20b. Imperial War Museum, H 10307, 21t. Getty Images/Topical Press Agency, 21r. Imperial War Museum, MH 3780, 22bl. Imperial War Museum, HU 81247, 22r. Getty Images/Central Press, 23rc. Alamy/Nigel J. Clarke, 23br. RAF Air Historical Branch, 23bl. Topfoto.co.uk, 23tr. Getty Images/Popperfoto, 24br. Author's collection, 24tr. The National Archives, 25tl & 25br. TRL Photographic Library, 25bl. Author's collection, 26cl, 26c & 26cr. RAF Air Historical Branch, 27t & 27c. RAF Air Historical Branch, 27b. Imperial War Museum, C 1013, 38t & 38bl. Author's collection, 38c. Mirrorpix, 39bl & 39cr. The National Archives, 39br. Author collection, 39tr. TRL Photographic Library, 40bl & 40br. Courtesy of NPL, 41t. TRL Photographic Library, 41b. The National Archives, 48t. Author collection, 48b. Imperial War Museum, ART LD 5799, 49tl. Author collection, 49tr. Imperial War Museum, MTE 3347, 49b Imperial War Museum, CH 16994, 50l. RAF Air Historical Branch, 50r. Getty Images/Fox Photos/Hulton Archive, 51tl & 51cl. RAF Air Historical Branch, 51tr Imperial War Museum, HU 44269, 51br. Author collection, 52. The National Archives, 53tl. National Portrait Gallery, London, 53tr. Author collection, 53b. The National Archives, 54bl, 54tr, 54br, 55bl, 55cr & 55t. RAF Air Historical Branch, 66t. Imperial War Museum, CH 8785, 66b Imperial War Museum, ATP 11384C, 67tr. National Portrait Gallery, London, 67b. Alamy/ImagesEurope, 68bl. Author collection, 68br. Author collection, 68r. Author Collection, 69t. Imperial War Museum, FLM 2352 & 69bl. Imperial War Museum, FLM 2354, 69br. Author Collection, 70bl. Imperial War Museum, FLM 2339, 70br Alamy/Chris Howes/Wild Places Photography, 71t, 71c & 71b. Imperial War Museum, FLM 2360, 2363 & 2343, 80b & 80t. RAF Air Historical Branch, 81t. RAF Air Historical Branch, 81b Author

collection, 82c, 82t & 82br. RAF Air Historical Branch, 82bl. Imperial War Museum, MH 842, 83t & 83c. RAF Air Historical Branch, 83b. The National Archives, 84t & 84b. RAF Air Historical Branch, 85t. The National Archives, 85bl & 85cr. RAF Air Historical Branch, 86tr. Imperial War Museum, CH 9687, 86c. RAF Air Historical Branch, 86b. Getty Images/Keystone, 87c, 87cl & 87t. RAF Air Historical Branch, 87cr. Author collection, 87b. The National Archives, 88bl & 88t. Imperial War Museum, C 5895 & HU 62922, 88br. RAF Air Historical Branch, 89t. & 89b. The National Archives, 90t. RAF Air Historical Branch, 90b. Author collection, 91bl. Author collection, 91tl. The National Archives, 91tr. RAF Air Historical Branch, 91br. Ruhverband Photo Archive. 110t & 110b. RAF Air Historical Branch, 111tl. The National Archives, 111tr. AKG-Images, 111c & 111b. RAF Air Historical Branch, 112r. Imperial War Museum, CH 9683, 112l. RAF Air Historical Branch, 113tr. Author collection, 113tl, 113cl, 113br & 113bl. RAF Air Historical Branch, 114b. The National Archives, 114t. Author collection, 115c & 115b. The National Archives, 115t. AKG-Images, 126t. Getty Images/Craig Roberts, 126b. RAF Air Historical Branch, 127tl. The Kobal Collection/Associated British, 127br. Mirrorpix, 128t, 128bl, 128br, 129t & 129b. RAF Air Historical Branch, 129c. Topfoto.co.uk, 130-131. Nicholas Trudgian, 132-141. Getty Images, 143. Imperial War Museum, MH 3780

Every effort has been made to acknowledge correctly and contact the source and/or copyright holder of each picture and Future Publishing apologises for any unintentional errors or omissions which will be corrected in future editions of this book.

MEMORABILIA

With kind permission of:

The Royal Air Force Museum: Items 2, 3, 4, 5, 6, 7, 8, 9, 13, 15 and 16.

The National Archives, Kew: Items 1, 10, 11, 12 and 14

FURTHER INFORMATION

Royal Air Force:

www.raf.mod.uk

Royal Air Force Air Historical Branch:

www.raf.mod.uk/ahb

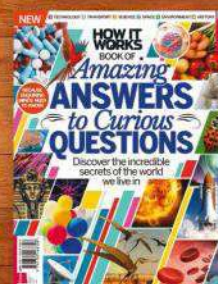
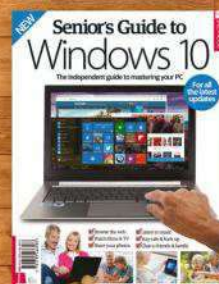
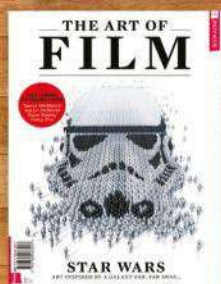
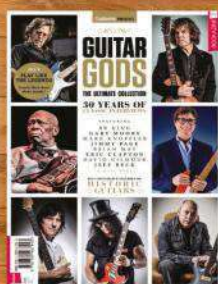
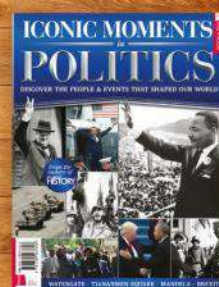
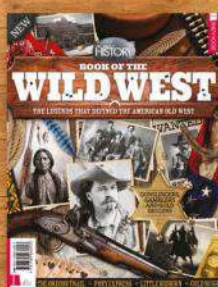
Royal Air Force Museum:

www.rafmuseum.org.uk

The National Archives, Kew:

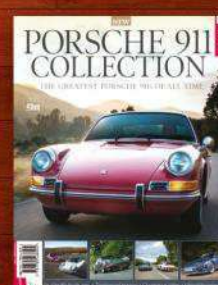
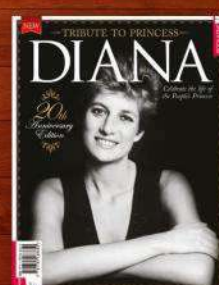
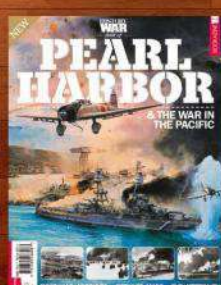
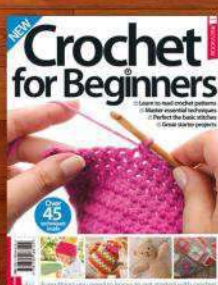
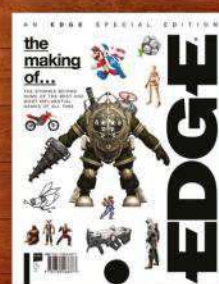
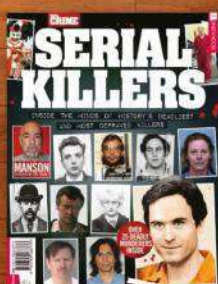
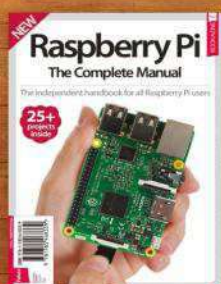
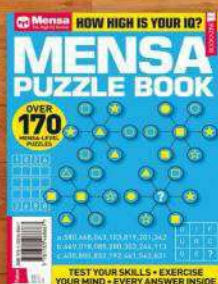
www.nationalarchives.gov.uk





Discover another of our great bookazines

From science and history to technology and crafts, there are dozens of Future bookazines to suit all tastes



Get great savings when you buy direct from us



1000s of great titles, many not available anywhere else

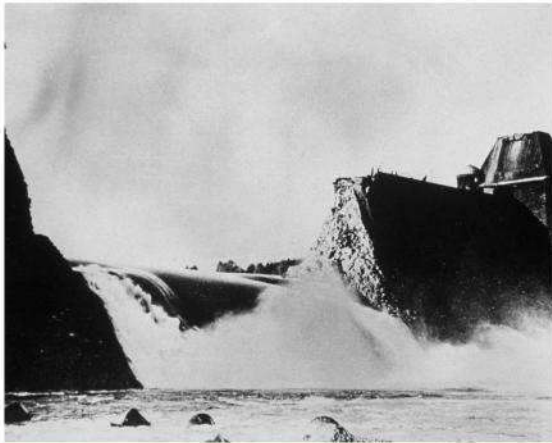


World-wide delivery and super-safe ordering



www.myfavouritemagazines.co.uk

Magazines, back issues & bookazines.



HISTORY
WAR

148
PAGES OF
HISTORICAL
IMAGES

THE DAM BUSTERS

INSIDE THE MOST DARING RAID OF WORLD WAR II



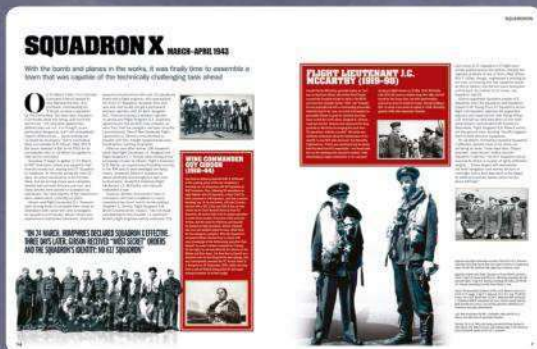
A SECRET WEAPON

Discover the science behind Barnes Wallis's bouncing bomb



ARTEFACTS OF WAR

Incredible unseen images and documents revealed



BIRTH OF A SQUAD

Meet the men that became heroes of Britain overnight



THE BOMB'S IMPACT

Find out how the raid on the Ruhr affected German industry